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REFUSE DESTRUCTORS FOR GENERATING POWER.

A problem confronting all large cities with increasing importance is the proper disposal of city refuse. A cheap method, widely used until recently, was to cart it away to dumps or throw it into the sea, but both these methods are now becoming objectionable. A more sensible way is to burn it, but, for some reason or other, city refuse destructors are somewhat rare. The trouble is that they are rather expensive, both in first cost and upkeep, and are not likely to be adopted until the community is forced to do so. The burning of the refuse, however, produces a certain amount of heat, which, if it could be utilized, would help to defray the expense of running the destructor. Whether it pays to do so is a question. So far but little experience has been had in this country in burning refuse. In Europe there have been a number of destructors constructed that have utilized the heat produced, but the question is still undecided. There are really two sides to it: first, is it advisable to burn the refuse? Second, does it pay to utilize the heat?

This problem was recently placed before Mr. Henry Floy, an engineer of New York city, by the city of East Orange, N. J., for a careful study, and his report has been submitted. In brief, it shows that it will not pay the city of East Orange to burn refuse as fuel for an electric light plant, because the same amount of heat can be obtained more cheaply by burning coal. The report shows also that it will cost considerably more to burn the refuse than to dispose of it as is done at present, by hauling it away. Of course, the question of cost in disposing of the refuse is not the vital one. The most expensive may, in the end, be the best and cheapest; but this is aside from the question of the advisability of constructing an electric light plant in conjunction with a destructor.

A few figures may be of interest. The report shows that the total cost of the destructor for burning the garbage and refuse only, but not the ashes, will be a little over $61,000, and that the approximate cost of destroying the refuse would be $1.35 per ton. If the destructor is to take care of the ashes as well it would have to be considerably larger, but the cost per ton of ashes and refuse destroyed would be only $1. This plant would cost $85,000, and the value of the heat thus produced would be only $1,000 per annum. Looked at from the standpoint of the central station this is certainly an expensive boiler house. It is thought not to be advisable to undertake the destruction of both garbage and ashes unless the heat produced be utilized in some way, as it would be considerably cheaper to destroy the garbage alone.

From a financial standpoint purely the prospect is not an

inviting one. It would cost considerably more to run the destructor than the present method of disposing of it, and it forms an expensive device for raising steam. Of course, this is hardly the proper way to look at the problem, as the value of the plant would be mainly sanitary. For this reason the undertaking might be advisable, but there is nothing in the report to show that a destructor plant would solve the problem of disposing of city refuse and of supplying the municipal lighting as well.

THE SAFETY OF ELECTRICAL SYSTEMS.

A short time ago occasion was taken in the ELECTRICAL REVIEW to reply to a charge that the electric motor is a dangerous mechanism. The opinion was expressed that this statement was entirely contrary to the actual facts, and such statistics as were available indicated that the introduction of the electric motor had done much to decrease the danger incident to many kinds of work. The only new risks incurred in the installation of electrical apparatus are the chance of shock to persons and of fire, and these can be reduced so as to be negligible if the owner of the apparatus chooses. If the present methods of installation do not accomplish this end, the fault must lie with the insurance companies, who may lay down any rules they please for the work. Aside from this one feature, which is new, and which is easily guarded against, there is a very considerable reduction in the danger accompanying the use of the electric motor as compared with other motors. It can be entirely enclosed, with the exception of the pulley, and even this disappears when the motor is direct-connected. Certainly, the elimination of long lines of shafting, with their accompanying belts, removes a dangerous element from the factory. Moreover, the electric motor can be controlled from a number of points, and it can be arranged so as to stop automatically in case of accidents.

Now another attack has been made on electrical systems, this time by the *Adjuster,* an insurance journal of San Francisco. This paper in an editorial entitled, "The Dangers from Electric Wires," says that there has been an increase in the death loss accompanying the development of systems of communication between distances and of transportation systems accomplished by a freer use of electricity. It says that as the discoveries of the uses of this power are made, and as its applications to the wants of civilization are accomplished, the penalties to life and limb appear to make disproportionate and alarming gains. It is thought that investigation along the parallel lines of safety is not pursued as vigorously as are the many profitable commercial uses to which electricity may be applied; that life is not guarded as it should be in this particular field of invention. As a specific instance, it says that the number of deaths and injuries resulting from the use of electricity, if compared with similar accidents produced by railroads, will show a death and accident list more than twenty per cent greater than steam. One of the chief dangers is thought to lie in falling wires, as the average citizen is apt to forget that the air above his head is charged with death.

It would be interesting to know how this conclusion is reached. Statistics sufficiently complete are not available to enable any such deductions to be made, and those which have been made have always shown a very different state of affairs. The reports prepared by the commonwealth of Massachusetts may be mentioned, as these are probably as complete as any drawn up anywhere. They have invariably shown a remarkably small proportion of accidents and deaths due to electrical apparatus.

Aside from the injustice of making such charges without submitting actual figures to substantiate them, it seems unfair to compare two very different fields of work and then to say that the power employed in one is more dangerous than that in the other. What, we wonder, would be the relative positions occupied by the steam engine and the electric motor if the former were required to operate through crowded city streets, while the latter had a practically clear right of way. The conditions are so entirely dissimilar—excepting, of course, a relatively small number of interurban lines which are operated electrically under conditions more or less approaching those of steam roads—that a comparison has no meaning whatever.

There is one feature in such comparisons that always seems to be overlooked: deaths caused by street railroads are caused by the car, and not by the motors—that is to say, the accident is due to the vehicle, and not to the system which propels it. The result would have been the same had any other power been employed. It is a fact that the electric motor is more easily controlled than any other kind of motor, and it is probably not far from the truth to say that were other motors used to propel our street cars that there would be more accidents than there are. The complaint should be made, not against the electric car, but against the method of running it. It is the high speed and the size of the cars which cause the trouble.

Nor does there seem to be such very great danger in overhead wires. The average citizen has a very wholesome respect for all electric wires, which is shown whenever one happens to come down; but his experience has taught him that this is seldom, so that he may pass under a pole line with confidence. However, it is a fortunate thing that the wires are being placed underground in cities, though this is rather to get them out of the way of firemen and to remove an unsightly obstruction from the streets.

It is, of course, regrettable that there should be any deaths caused by electric shock or apparatus, but our present methods of living involve a certain amount of risk. In this the electrical industries are no more peculiar than any other. Every electrical engineer believes that in producing electrical methods he is really reducing the dangers, for it should be remembered that the electrical industries are growing at a wonderful rate, so that one should expect that there would be more accidents to-day due to electrical appliances than occurred five years ago. Comparisons should always be made on a common basis; otherwise they are absolutely valueless. Nor do unsupported charges accomplish any real good, and they are apt to react upon the accuser.

ELECTRIFICATION OF STEAM ROADS.

The electric railway engineer should be given much credit for his unwavering confidence, both in the apparatus he employs and in his own ability as well. He first displaced the horse from his old and honored place, and while doing this had to bear the scorn of the horse-car men and the taunts of the engineers of the newly introduced cable. Having secured a much needed rest for the horse, he next attacked the cable, and in spite of the assurance of many well-known engineers that the cable was ideal for very heavy city work, he has left it hardly a wheel to run on. From the cable he rose to the steam elevated roads and banished them in a cloud of smoke. In the meantime he was practising for the final act by building high-speed interurban railroads and devising means for doing away with the steam locomotive in tunnels and other dark places. Now he turns a keen, untroubled face towards the entire railroad system of the country and says that he is ready, whenever the railroads are, to drive the noisy, dirty, coal-burning locomotive into innocuous desuetude. At least some of him are, though there are others who dread the effect of breaking up apparatus that represents so much investment. For some years past the more sanguine electrical engineers, including those who have systems believed to be suitable for heavy railroad work, have been prophesying, on all proper occasions that the years of the steam locomotive were numbered, yet these assertions were listened to quietly and no undue excitement was caused. It was pointed out that if, or when, the electric displaced the steam locomotive, the work would go forward along certain lines, but there was said to be no hurry; there is plenty of work yet to be done in less pretentious ways, and it will be time enough to clean up the trunk lines when all the twigs and branches have been put in order.

However, the necessities of certain comparatively short sections of large steam roads have renewed, or rather accentuated interest in the greater problem, for it has never died down completely, and this interest was brought to a focus at the recent meeting of the American Institute of Electrical Engineers, at which a paper was presented by Messrs. Lewis B. Stillwell and Henry St. Clair Putnam. This paper, which was entitled, "On the Substitution of the Electric Motor for the Steam Locomotive," is given in condensed form in another part of this issue. It is the most detailed attempt yet made to show that the electric locomotive, as already developed, offers us a more economical method of operating all our railroads. In brief, the paper consists of a detailed comparison of the various items of the expense of operating a railroad by the two methods. The costs for steam operation are taken from the statistics compiled by the Interstate Commerce Commission, while the costs for electric operation are deduced from various sources, some being roads in actual operation, others from tests, and still others from a careful study of the various factors entering into those particular phases. The conclusion drawn from this comparison is that electric locomotives would reduce the cost of operation by $250,000,000, the aggregate cost of operation for all the railroads in the country being $1,400,000,000 for 1905. This is equivalent to reducing the cost of operation per mile of track from $6,409 to $5,265, a saving of $1,144 per mile.

The most severe criticism of this result was that the statistics for steam operation are none too reliable and that the costs for operating by single-phase alternating currents were based largely upon the results of direct-current operation. The authors themselves, however, do not advocate immediate electrification of the steam roads. The work is too stupendous to be undertaken hastily, and the financial problem is one requiring much sober thought. Nevertheless, ability to save nearly eighteen per cent of the cost of operation, equivalent to nearly twelve per cent of the gross earnings, according to the estimate given in the paper, should be of interest to railroad owners.

Another feature of this paper is the unhesitating adoption of the high-voltage, single-phase system. The direct-current system is discarded as not filling the bill. There can be no question of the possibilities offered by the single-phase system, but it should be remembered that it has not yet been thoroughly tried out. Moreover, the newer forms of direct-current motor deserve at least a trial. Railroads do not, as a rule, exchange locomotives, and there should not be much difficulty in adapting the lighting of the cars to either system, which would enable them to run anywhere. If one system will save say, twenty-five per cent of the cost of electrification of a particular railroad, the cheaper would probably be adopted irrespective of what neighboring roads were doing. In this connection the description of the high-voltage, direct-current system to be tried in Vienna, Austria, which is given on another page of this issue, is interesting.

A third feature of the paper presented by Messrs. Stillwell and Putnam is the plea for standardization. It is urged that this should be done at once and a single-phase, alternating-current, with a trolley voltage of 11,000, fifteen cycles, is thought to be on the whole the most satisfactory. Standardization is always desirable, when experience has shown conclusively what is the best practice. At the present, when so much pioneer work is being done, and with the prospect of soon having data on the actual operation, it seems that nothing will be lost by waiting a while. However, those who took part in the discussion seemed to agree pretty well that fifteen cycles is the frequency most satisfactory so far as the motors are concerned, and as the running equipment is more expensive than that required for the power-house, the former should receive the first consideration. A low frequency enables a much more suitable motor to be constructed, and for heavy railroad work this is likely to be the ruling consideration. Fifteen cycles apparently is about the proper compromise.

The problem of electrification seems to be entering into a new phase which demands the earnest consideration of railroad operators. Is it not about time for the mechanicals to think about becoming electrical engineers, since to do so should require only a slight effort on their part, a good electrical engineer being, according to their definition, nine-tenths mechanical?

LIGHTING OF RAILWAY PREMISES: INDOOR AND OUTDOOR.[1]

BY HENRY FOWLER.

Passenger-Station Lighting—The space to be lighted in a station consists mainly of the platforms, and this necessitates the lights being placed in long lines down these platforms. The best position for these is nearly in the centre of the space to be lighted. Where there is a wall or building on one side, and the platform edge on the other, they should be slightly near the former, as the lamps are usually employed, in addition to their use for lighting purposes, as a means of denoting the name of the station. On open platforms, columns, etc., form obstructions, and are therefore placed so as to leave as great a space as necessary between them and the platform edge. It is absolutely essential that the edge of the platform itself should be well defined.

In many cases the positions of the lamps are to some extent determined by the positions of buildings, passages, etc., which have to be lighted, and by the roof, which may allow of lights only being fixed at multiples of certain distances apart.

Height is a most important point, not only in station lighting, but in all other, as upon it depends the general character of the horizontal illumination. The ideal arrangement is to have a light of great intensity fixed at great height, when the illumination will be as even as possible. This, of course, is impracticable and would lead to much loss of light, as only a small portion of the spherical intensity would be utilized. In actual practice the distance the lights are apart has to be taken into account, and although Mr. Trotter[2] has spoken in favor of the ratio of height to distance being as one to three, yet in ordinary railway work the ratio for station lighting is usually not less than one to five or one to six, and still the effect is good.

An electric arc should, if patchiness is to be avoided, be placed fairly high. Above all things, in lighting any space effectively, the fault of patchiness should be avoided. Nothing is more displeasing than to have violent contrasts of illumination close together, and often a portion of a space looks badly lighted simply owing to its being compared with a much more brilliant patch near it. All variations of illumination should be as gradual as possible, and this is one of the chief reasons for surrounding arc lamps with opaque globes, which, although they retard a portion of the light, allow a better general effect by distributing the light more evenly. On a railway station the lowness of the roof often prevents the lights being placed at the desired height, and in these cases the only satisfactory method is to use a number of small units close together so that contrasts in illumination may not be too marked.

In many small stations the effect of the light given by the train must not be forgotten. The passengers are so few that they can often be accommodated in the waiting-rooms, and only use the platform when the train is in, and when the carriage lamps give a good light on to the platform itself. In these cases all that is necessary is to provide sufficient light to prevent accidents.

Undoubtedly the best type of station to light satisfactorily is one with a large span roof, the sides of the buildings being of light-colored glazed bricks. Various considerations often prevent these being built, and then the precautions already mentioned should be taken in order to insure satisfactory lighting.

Freight Yards—In lighting freight yards and sidings, as distinct from goods sheds, two conditions may obtain; it may be that it is necessary to provide for lighting a space, as, for instance, the entrance of a yard, or a particular point, such as a capstan. Upon these considerations the type of light used will depend. In the first case high-power lights are required, and they should be placed high up so as to distribute the light; in the second case a smaller light at the point required is all that is necessary. For the lighting of the yards themselves three-light incandescent gas lamps, about eighty to 100 feet apart, or arc lamps about 100 to 120 feet apart, give a good effect, and quite sufficient illumination under ordinary conditions. It frequently happens, however, that the necessity for providing light at some particular point, such as a crane, capstan, crossing, etc., causes the lamps to be placed much closer together. In small yards, where neither electricity nor gas is available, Veritas oil lamps in suitable cases may be used. It will be understood that the conditions vary so much that illumination curves of lighting of this description are not of much value, but from a number of readings which the author has taken, he thinks that if the light provided does not sink below 0.05 foot-candles at the ground level it will meet any case. In the lighting of sidings, the chief position to be considered is that of the points. Here it is necessary not only to light the points themselves, and the position of the "dummy" for changing them, where provided, but also to show when a car is standing clear where the roads diverge, so that shunting may take place safely by it. The lighting here required is therefore a combination of horizontal and vertical illumination, and if a single pair of points has to be dealt with, a light of not too high power (say 100 candles), placed at not too great a height, is all that is required. Where several sidings run one after another into a shunting road, and a line of lights is provided, three-light incandescent gas lamps, 100 feet apart, or arc lamps on higher posts and spaced a greater distance, will be found satisfactory. In some cases special lighting has to be provided, and as a case in point the author would quote gravitation sidings such as now exist on most railways. Here the number of the road the car is to go on is chalked on the end of the car before it is "cut" from the train and started down the incline. It is necessary that this number should be easily read, and in order that this may be done, the author has found that three-light incandescent gas lamps, with reflectors behind the mantles, on fairly low posts, answer this purpose admirably. At points where trains are broken up on these sidings, a particularly good light is required, and a minimum illumination of 0.15 foot-candle found none too much.

Freight Sheds—Here, even more than on stations, the points available for fixing lights are very confined. It often happens that the jibs of the cranes sweep so close to the principals of the roof that the space left between is too small to allow of the fixing of a light, while such a position would be a dangerous one for men attending to the lamps when this became necessary. The result is that lights are usually fixed along the stage of a shed, not down the centre, but "staggered" on alternate sides so as to miss the swing of the cranes. An ordinary shed consists of platforms with cranes, with a cartway on one side and a siding on the other. The cartway is often so wide as to require some light down it, and this is provided by a line of lamps placed at sufficient height to prevent damage from high loads. On the platforms a good light is essential, owing to the necessity of reading quickly and easily labels, written sometimes in all styles of writing with every color of ink. With gas lighting, groups of two or three incandescent burners in lamps placed from thirty to forty feet apart, and from eleven to thirteen feet above the platform, are found to give a satisfactory light, the illumination—neglecting the portion directly

[1] Abstract of a paper read before the Institution of Mechanical Engineers of Great Britain, December 14.

[2] Proceedings, Institution of Civil Engineers, of Great Britain, vol. cx, page 69.

under the lamp—varying from 0.9 to 0.25 foot-candle.

Locomotive Sheds—The sheds of the Midland Railway Company are of two types, either square ("round") with a turntable in the centre and pits radiating from it, or rectangular with an entrance at one end and pits running down the length of the shed. The lighting was formerly carried out by means of Star or similar gas lights with four, six or eight burners, each consuming about five cubic feet per hour. In the case of the "round" sheds these lights were placed between every other pit, with the result that one side of each engine was left in darkness. Upon the advent of the incandescent burner, these old lights were replaced by two-light incandescent burners, either in lamps or under shades, which were placed between each pit. The result was that not only was a better and more evenly distributed light obtained, but a considerable economy was effected in the cost of lighting. With the rectangular sheds the lights usually required rearranging. The results, so far as improvement in lighting and economy are concerned, were, however, the same as with the "round" sheds.

Lighting of Workshops—With the exception of the shops in which the locomotives or cars themselves are erected or repaired, the general conditions and arrangements in railway works are very similar to those found in any engineering works.

Lighting of Locomotive-Erecting Shops—In lighting a locomotive-erecting shop, certain initial difficulties are met with. These are the need of a good general well-diffused light, and the fact that, as cranes run down the whole width and length of the shops, the light must be at least twenty-nine feet above the floor level. The author was met with these difficulties when asked to improve the illumination of a large erecting shop of three bays, each measuring 450 feet by fifty feet. At first arc lamps, under large white-washed reflecting boards, were tried above the cranes, but for one reason or another were not wholly satisfactory. These lamps were then superseded by arcs placed between the columns separating the bays, but this did not provide a sufficient light in the centre of the shop. About this time a smaller shop was erected at Kentish Town, and the author lighted this by high-pressure gas burners, placing three of these under a white-washed reflector.

Brass Foundry—The satisfaction given by this lighting and its economy has led to its being adopted in all shops where a good general light is required, such as those in which boilers, tenders, etc., are dealt with. It has even been installed in the brass foundry at Derby, and has been found very satisfactory. The height the burners are fixed above the floor (twenty-one feet in this case) is apparently sufficient to prevent their being interfered with by the dust, etc., which is always found in such shops.

Fitting Shops—In fitting and machine shops, although a general light is required, yet particular points require special attention unless the general illumination is very good. J. A. F. Aspinall has shown the success achieved by fixing arc lamps under large white-washed screens in the fitting shop at Horwich. The construction of this building has allowed of the systematic arrangement of a large number of arc lamps, and the author, who has worked both on machines and at the bench in this shop, can testify to the excellent effect given.

In the shops he has had to deal with, the construction has not admitted of the employment of large units of light, as, to use them successfully, they must be placed at a considerable height above the surface to be illuminated. With gas available at a very low cost, extensive use has been made of the two-light incandescent gas fitting under a twenty-eight-inch enameled shade. The use of a smaller unit of light, such as this, allows of a much better illumination when the lights have to be fixed lower down.

In some cases, owing to the provision of cranes, or from other causes, it has been found necessary to provide a special light for a vise. In such positions a single light has proved useful. These have also been employed to light a row of lathes fixed against a wall, and where it was not thought advisable to provide large units of light high up. In these circumstances they are fixed to the wall behind the lathe.

Paint Shop—In both locomotive and carriage paint shops, not only is a good light required, but it has to be provided in long rows to illuminate thoroughly the vehicles on each side. In dealing with these cases, a two-light incandescent gas fitting has been found very successful.

Car Shop—With lighting of car shops generally, the same conditions occur as are found in locomotive paint shops. These prevent the provision of high units of light, especially as the shops are of necessity not so high as locomotive erecting shops, as cranes are not often used. The same system of lighting has been adopted as with the locomotive paint shop already quoted.

Iron Foundry—The lighting of iron foundries seems to be one particularly suited to arc-lamps, but the author, from his experience with high-pressure gas lights in the brass foundry, believes that this system of gas lighting may successfully be employed in illuminating what is usually the one dark spot about a works. At Derby the side of the foundry on which light work is carried out, and along which no crane runs, has been lighted for some time with ordinary incandescent gas burners. On the section where a crane is necessary to deal with heavy castings, etc., high-pressure gas lights under white-washed reflectors have been installed. In this connection it may not be out of place here to refer to the very strong influence of dark walls, floor, etc., and the floor of a foundry is never in any sense a reflector, while the dust which settles on, at all events, the lower parts of the walls, prevents them doing their part in the general illumination. The question of the color of surroundings on lighting effect, although often referred to, is too often neglected.

In conclusion the author would again point out that if he has seemed to deal with the question of gas lighting somewhat to the exclusion of other types, it is because he has of necessity had to speak of the lighting that he has had most to do with.

Report of the Commission of Gas and Electricity for the State of New York.

The second report of the Commission of Gas and Electricity for the State of New York, sent to the legislature on January 28, shows that there is a total of 426 corporations, municipalities and individuals furnishing gas and electricity for heat, light and power in the state coming under the supervision of the commission. The capitalization of these companies aggregates the sum of $546,000,000, and the gross income from operation approximates $75,000,000 per annum. Of this number fifty-one plants furnish coal or mixed coal and water gas; 162, electricity; fifty-one, both gas and electricity; twelve, acetylene gas; thirteen, gasolene gas, and forty-one, natural gas. Of the municipalities engaged in furnishing light, three furnish gas and thirty-five electricity.

The commission recommends that the law be amended so that a complaint as to price, quality and purity of gas or electricity may be made by twenty-five customers in the territory served where it contains less than 1,000 population; by fifty customers where the population is between 1,000 and 5,000; by seventy-five customers where the population is between 5,000 and 10,000, and 100 in all other places. The commission also recommends that municipal gas or electric plants should be compelled to make annual reports to it.

The New Electric Locomotive for the Vienna, Austria, City Lines.

By C. L. Durand.

IT is proposed to use a new system of electric locomotives which will replace the steam locomotives now in operation on the Vienna, Austria, city lines. This relates to the Metropolitan road lying entirely within the city limits, which has a total length of nearly seventeen miles. A considerable part of the road lies in subway, and the use of steam locomotives is disadvantageous on account of smoke and dirt. Owing to this reason the road is not as well patronized by the public as it would be otherwise, and it is only natural that steps should be taken to change the road over to the electric system. On the Vienna lines the trains are drawn by locomotives which are required to take a load of 140 tons, not counting the locomotive, upon a maximum grade of three per cent. It is estimated that the locomotive requires 570 horse-power on the average, but this may rise as high as 700 horse-power at the maximum. According to the company's schedule, there are at times of heavy traffic about twenty-one equal trains running upon the line; and the total power needed from the locomotives in this case is 14,700 horse-power, or very nearly 770 horse-power per mile, but on the sections of heaviest traffic this will rise to 2,000 horse-power per mile of track.

The Minister of Railroads is considering the question of using electric locomotives upon the entire road, and accordingly applied for projects of this kind to several of the leading firms of the country with the understanding that a successful system would have a good chance of being adopted in the near future. Seeing that coal has to be brought from a great distance and is, therefore, expensive, it is also proposed to run the electric line from a hydraulic plant situated in the neighboring region.

One of the leading electrical firms of Austria, the Krizik Company, of Prague, has already constructed an electric locomotive which is designed to meet the above conditions, and it is to be tested by the Railroad Department upon a short section of railroad. For this purpose the standard overhead trolley wire construction will be used, so that the locomotive can be tested under the actual running conditions. The following information about the new locomotive has been furnished the writer by the Krizik Company.

As regards the time intervals, these will be somewhat reduced for the electric system, and on some of the more crowded sections, trains will be run at two and one-half minute intervals. The average train will be made up of six or seven passenger cars. A maximum speed of twenty-five miles an hour is taken as the standard. The experimental section, between the stations of Hauptzollamt and Praterstern,

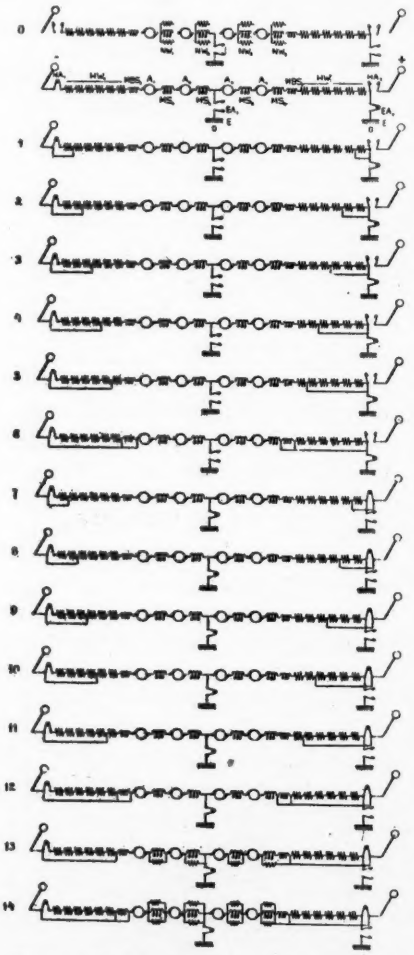

FIG. 1.—DIAGRAMMATIC ARRANGEMENT OF MOTOR CONNECTIONS.

will be about 1.2 miles long. It was decided to use a locomotive having two axles, with two direct-current motors geared to each axle. The current is brought on the three-wire system, using 3,000 volts between the two trolley wires which form the outer conductors, with a ground connection forming the third conductor. The method of connecting the four motors, which are run as series motors, is best understood by referring to the diagram (Fig. 1). Two motors on each side of the ground wire are permanently connected in series, along with starting resistances. With the four motors in series, each one receives the standard voltage of 750 volts which is chosen here. The controller and ground-switches allow of making different combinations so as to give various speeds. About 130 horse-power is taken by each motor, making 520 horse-power for the whole locomotive. The total weight of the locomotive is about thirty tons.

For the overhead construction of the trial portion, a trolley wire was chosen which should be of the same section as was proposed to be used upon the whole system, admitting it to be fed at two different points and assuming three per cent loss. The section of the trolley wire is 115 square millimetres, and the wires are placed symmetrically to the centre of the track, being spaced four feet six inches apart and lying sixteen feet above the rail level. Each of the wires is suspended separately, as will be observed (Fig. 2), so that an accident to one will have but little effect on the other. Trolley-hangers with double insulation are used here (see section) having been tested at 30,000 volts. They are suspended from steel wires and the latter are held at each end upon the cross-beam by insulators. The railroad track is double, and the overhead lines are laid out so that there is a like polarity between the two inner and the two outer wires. Seeing that both the inner wires are of the same polarity, it is not necessary to provide special insulation between them in the case of crossings, but these are needed only where they come near the outer wires. In the diagrams will be seen the general disposition of the trolley wires and track (Fig. 3).

The construction of the experimental locomotive follows very closely the design which it is intended to use upon the Vienna system, and the only difference lies in the fact that the controller is placed in the middle of the cabin, so that it will be easier to observe its working during the trials. Its general appearance is shown in Fig. 4. Upon the frame are mounted two axles, using a wheel diameter of forty-eight inches with a spread of ten feet. The axle and wheel construction is according to the standard which is used on the Austrian state railroads. Between

buffers the total length of the locomotive is very nearly twenty-four feet. With respect to the distribution of the electric apparatus, the locomotive is built symmetrically. Each axle is operated by means of single-reduction gearing from two electric motors, the latter being suspended from the chassis, so that the weight of the motor does not come upon the axle. Upon the under framework is mounted an entirely enclosed cabin which contains two motorman's posts and is provided with large windows. In the separate spaces in the sloping ends of the locomotive are lodged different apparatus which will be mentioned, and these can be reached by lifting up a top cover. The cabin and the end chambers are built of one-tenth-inch sheet-iron and angle-iron, while the roof construction is reenforced to some extent, as it is to carry the two trolleys. As regards the brakes for the locomotive, the constructors adopted the system which is used on the state railroads, namely, the Hardy vacuum brake with a quick-action valve. Each of the axles is provided with a brake cylinder which is used to operate four brake-shoes, two upon each wheel, and the adjustment is made so that the pressure is equal upon the shoes. Both cylinders are coupled together by piping, so as to secure the same vacuum and, in consequence, an equal pressure in each. In the present case the vacuum for the brakes is given by two motor-driven vacuum pumps. A motor-operated air-compressor is also carried on the locomotive in order to work the sand-blast apparatus, seeing that the adhesion of the locomotive is limited by its weight of thirty tons, and in bad weather the sand apparatus is essential. It distributes sand upon the forward axle in each case and can be operated from either of the working posts. The compressed air is sent by the pump into a reservoir containing about twenty-five gallons, which supplies the sand feed for the wheels. Compressed air is also used for the signal whistles of the locomotive. Mounted at each motorman's post are the necessary pressure-gauges and vacuum indicators, as well as the safety valve for the air-compressor. From each axle a speed indicator on the Hausshälter system is driven by chain connection and is arranged to ring a bell when the locomotive reaches a speed of thirty-six miles an hour.

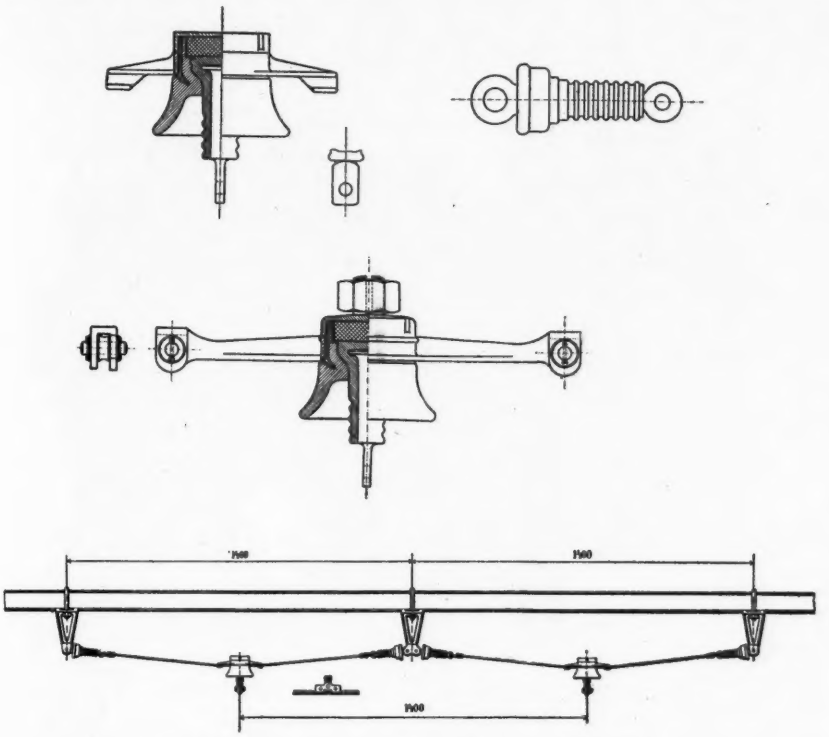

FIG. 2.—DETAILS OF OVERHEAD TROLLEY SUSPENSION.

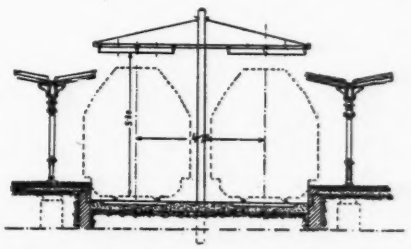

FIG. 3.—RELATION OF TROLLEY SUPPORT AND TRACK.

FIG. 4.—EXTERIOR VIEW OF LOCOMOTIVE FOR VIENNA CITY RAILWAY LINES.

One of the main features of the locomotive is the newly designed system of motors. There are four similar motors mounted on the locomotive, of which two motors work upon a common axle. The general arrangement is indicated in Fig. 5, which shows the exterior and interior design and the manner of mounting upon the axle. Built on the iron-clad plan, the casing of the motors is in two halves, and the upper half has cast with it the lugs which contain the bearings of the axle. In this way the axle, besides the two axle-

boxes on the outside of the wheels, is made to run in four bearings. The motor casting has two air openings below which are protected against water, but they allow a good air circulation inside the motor. Above the commutator is a cover which gives a third opening and allows the heated air to escape. The motor has four poles cast with the body, and upon these are fitted laminated iron pole pieces carrying the field coils. The motor is also well shown in Figs. 6 and 7.

A slot winding is used for the armature, and the latter is well cooled by an interior air space near the shaft and two openings which are left between the plates. Lathe-wound coils are laid in the slots, and owing to the high voltage the insulation is well carried out. Each coil is covered with mica and then wrapped in varnished cloth strips, being afterwards dried in the oven. Before placing the coils, the slots are lined so as to give a mechanical protection to the coils. The armature winding is carried out on the usual four-pole series plan, and the coils are held in place by silicon-bronze binding wires. As the commutator is mounted upon a spider, a good air inlet for the armature is given at this point, and the commutator is specially insulated against sectional and surface leakage. On one side it is protected by a wide ambroine ring and on the other by a mica washer. All four motors of the locomotive are built for the same capacity, namely, for 130 horse-power, net. They operate upon 750 volts and 135 amperes, working at the standard speed of 545 revolutions per minute. The principal data for the motor are here given. Armature diameter, fifty-one centimetres; net length of iron, 27.2 centimetres; number of slots forty-six, measuring 1.72 by 3.64 centimetres; air-gap 0.5 millimetres; section of conductor, 13 by 1.2 millimetres with twelve conductors per slot; fields, main section, 554 square centimetres; length of pole-piece, thirty centimetres; coils, sixty-six turns of 7.8-millimetre wire; armature resistance, warm, 0.1632 ohms; field, 0.1280; heating, fifty-four to sixty-one degrees centigrade.

The reduction ratio from the motor shaft to the main axle is eighteen to seventy-eight between the main gear and the pinion. The large gears are made of cast steel, while forged steel is used for the pinions. As will be observed, the gearing is protected by the usual casing. As has been already mentioned the locomotive is supplied with direct current on the three-wire system with 1,500 volts between the pairs of wires. The different connections for the circuits of the motors and the various apparatus are shown in the accompanying diagram (Fig. 8). It will be observed that the current is taken from the overhead wires by the two trolleys Sta_1 and Sta_2. Both poles are protected by horn lightning arresters. The current for the two motors passes by the safety devices Ss_1 and Ss_2, to the automatic circuit-breakers Ma_1 and Ma_2, which can also serve as emergency switches.

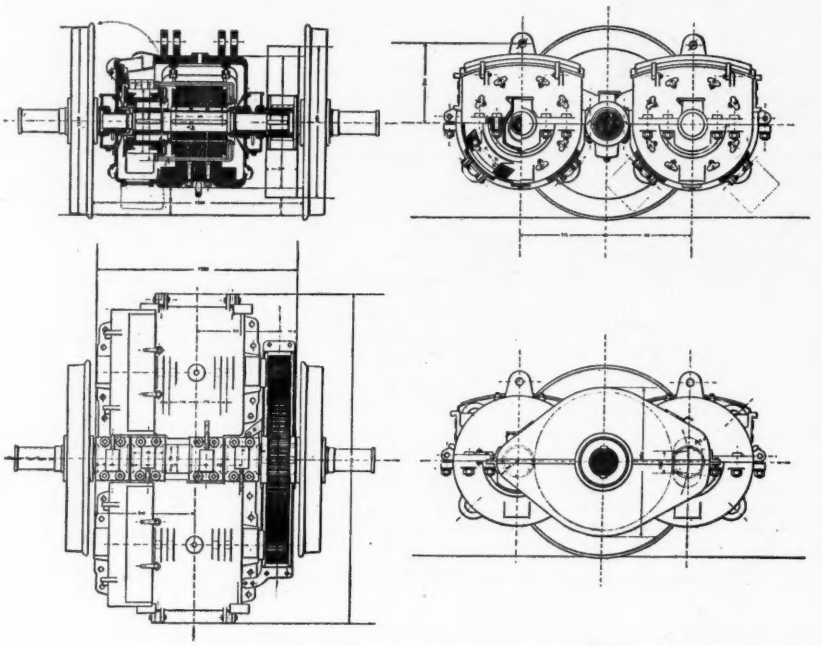

FIG. 5.—ARRANGEMENT OF CAR MOTORS, LOCOMOTIVE FOR VIENNA CITY LINES.

From here the current passes through the shunts Sh_1 and Sh_2 which are used with the double-indicating ammeters A_1 and A_2. These instruments show the value of the current in each branch of the circuit. Next comes a reversing switch which changes the direction of the current in the motor and causes the locomotive to run forwards or backwards.

From the reversing switches the current is brought to two high-tension switches Ha_1 and Ha_2 which are provided with the magnetic blowout solenoids Mb_1, Mb_2, after which it passes into the magnetic blowout coils of the main controller drums Mbs_1, Mbs_2, and thence into the set of controller contacts. The controller drums send the current by way of the series resistances Hw_1, Hw_2, to the motor field coils M_1 to M_4 and also to the armatures A_1 to A_4, of the four motors. As to the shunt resistances Wn_1 to Wn_4, they are connected in the controller to a set of contacts shown at the sides.

To connect the circuits to ground there

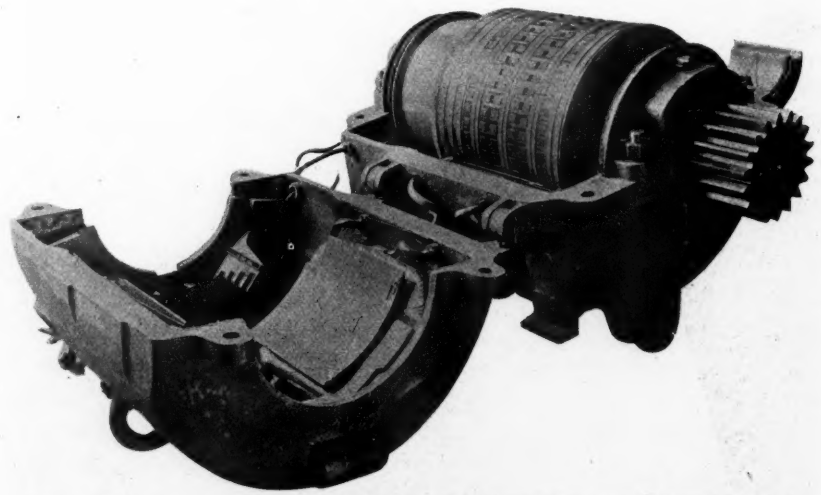

FIG. 6.—ONE OF THE 750-VOLT, DIRECT-CURRENT MOTORS FOR THE LOCOMOTIVE FOR THE VIENNA CITY LINES.

are provided two ground-switches, Ea_1 and Ea_2, which have a magnetic blowout. These switches, as well as the main switches, are operated from the controller drums by means of a set of levers and disc transmission. Connected with the corresponding side contacts of the controllers, the switches operate the last break of the current as well as the first current connection, so that the contact pieces of the controllers are free from sparking from this cause. The last-named switches come into use only where it is desired to make or break the main current, or where the circuit is thrown from half to full voltage, or reversed.

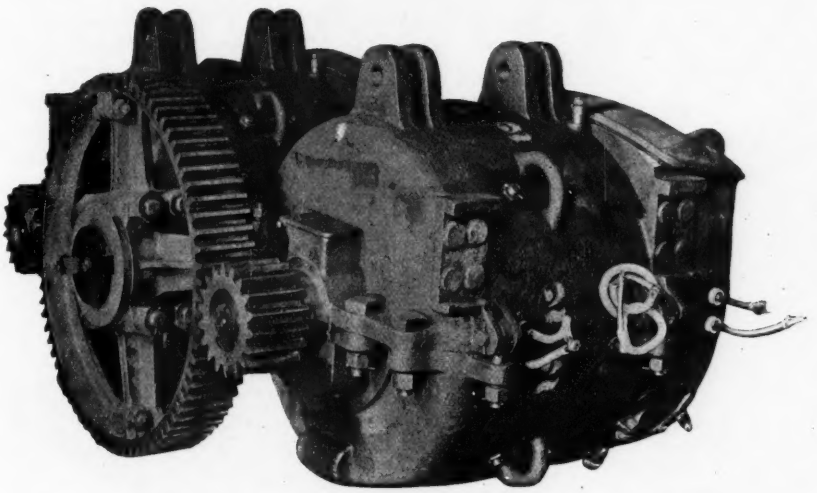

FIG. 7.—MOTORS FOR ELECTRIC LOCOMOTIVE, SHOWING METHOD OF GEARING TO MAIN AXLE.

In front of the safety devices a part of the current is taken off for use in the air-pump motor Lm, which is used for the air-brakes. This motor is designed as a double motor so as to run on 2 x 750 volts. Its speed is regulated by two controllers, Lkm_1 and Lkm_2, which can be operated from either post, and are provided with magnetic blowouts. Another circuit leads to the air-compressor motor Cm, which is shunt-excited and has a starting and regulating resistance An.

The main controller for the locomotive is shown in Fig. 9. In the present locomotive it has been placed in the middle of the cabin in order to note its action during the experiments. A hand-wheel placed at each motorman's post allows of working the controller drums by means of a transmission device. The hand-wheel is mounted directly before the main windows at the ends of the cabin, and a set of bevel gears connect it with a vertical rod which is geared underneath the floor to a long shaft which passes below and is connected with the controller drums by chain-driving. As regards the controller drums these are of about the usual design, but in this case are placed in a horizontal position. Each contact is provided with a magnetic blowout. Mounted on the top of the controller framework will be noticed the main and the ground switches, which are designed in a special form so as to prevent arcing. Inside the switch and placed between the two side protecting coverings are two long lever arms with carbon contacts on the ends. The arms are mounted each upon a separate shaft which carries a toothed segment and can be thus operated from the controller, so that the carbons are quickly drawn apart and the arc broken. A magnetic blowout, whose coils are noticed on the outside, aids in this operation. The two protecting plates are lined with an incombustible insulation and form an air-chamber, so that the sudden heating of the air also has an effect in blowing out the arc.

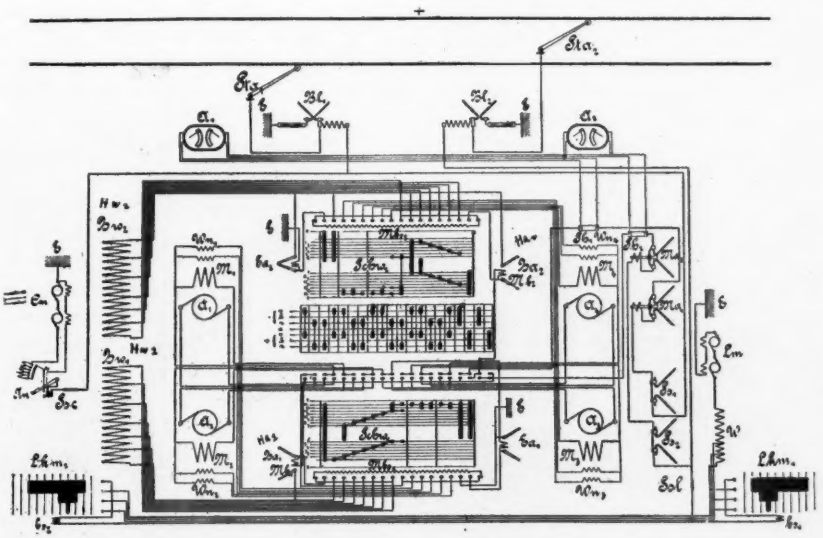

FIG. 8.—MOTOR AND CONTROLLING CIRCUITS, LOCOMOTIVE FOR VIENNA CITY LINES.

On the roof of the locomotive there are mounted two collectors corresponding to the two-line wires. Of the extensible or pantagraph type, they are built of steel rods, and are pressed up against the wire by two sets of springs. The first of these is placed in the middle of the frame, and is used for an elevated trolley wire, while the second set of springs in the base comes into use for a low-hanging wire where the collector is lowered considerably. The main shaft of the collector is made of the best cast steel, and is lubricated with graphite. Current is taken from the collector into the car by means of a set of carbon brushes, which are pressed up against the shaft by springs, so as to give a good contact. The collector is mounted on wood braces which are insulated from the roof of the locomotive by ambroine insulating pieces. It is intended to provide the collector with a pneumatic system in the next construction, which will replace the springs, and make it easier to handle and to regulate the pressure.

In the chamber at one end of the locomotive are mounted a number of resistance coils. These consist of a flat coil made up of German silver strip insulated with asbestos and mica. The winding is double, so as to avoid any induction effects. Here the coils are set in an upright position and mounted each upon a pair of porcelain insulators, while the entire series is mounted on an iron framework which is insulated from the locomotive body by large porcelain insulators. The air-pump for the vacuum brakes is also mounted at the end of the locomotive.

Coupled in the middle between the two pumps is a specially designed series motor which runs upon 1,500 volts and is rated at six horse-power. This motor is built as a double motor, so that each of the armatures operates on 750 volts. From each post the motorman can control the motor as well as the air-pumps by means of two brake-controllers. At the same time the vacuum brakes can be operated by this device. The brake-controller has eleven points. In positions one, ten or eleven the current is cut off the controller, but in all the other positions the motor is set running and works at different speeds according to the resistances which are placed in the circuit. Positions one to three serve to start up the motor, and

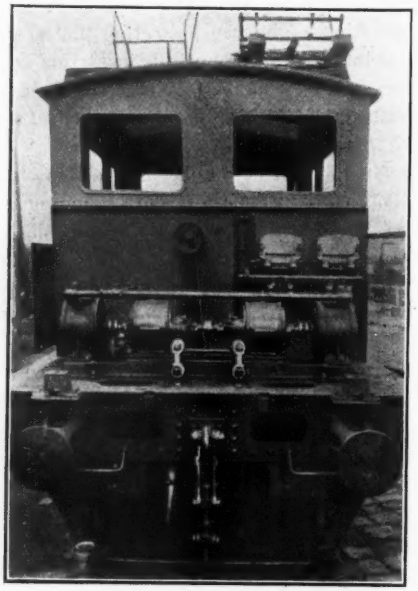

FIG. 10.—VIEW OF LOCOMOTIVE SHOWING MOTOR-DRIVEN VACUUM PUMPS AND AUXILIARY APPARATUS.

for this purpose the whole starting resistance is thrown on in position two, and but half the resistance in position three, while at point four the motor runs without resistance. Since the desired vacuum is reached soon after the start, the pump can then be run at a lower rate, simply to supply the leaks in the piping, and the controller positions five, six and seven are used for this purpose. Between points seven and eight the brake valve commences to let air into the piping from the brake cylinder, and from this point to position ten the desired air-inlet can be secured so as to give the proper braking action. The vacuum start is placed in the under part of the locomotive chassis. For working the sand distributor as well as the signal whistle a compressed-air system is used on the locomotive, which consists of a high-speed air-compressor coupled to a two-horse-power motor running on 1,500 volts. It is also of the double form and has somewhat the same design as the above motor, each half working on 750 volts. The air-compressor, coupled to the motor, gives a pressure of seven atmospheres.

The end view (Fig. 10) of the locomotive and the accompanying diagram (Fig. 11) show the general arrangement of the different apparatus of the locomotive. In one end are the air-pump with its motor and reservoir, as well as the controller resistance coils in their frame. In the middle of the cabin is the controller, and

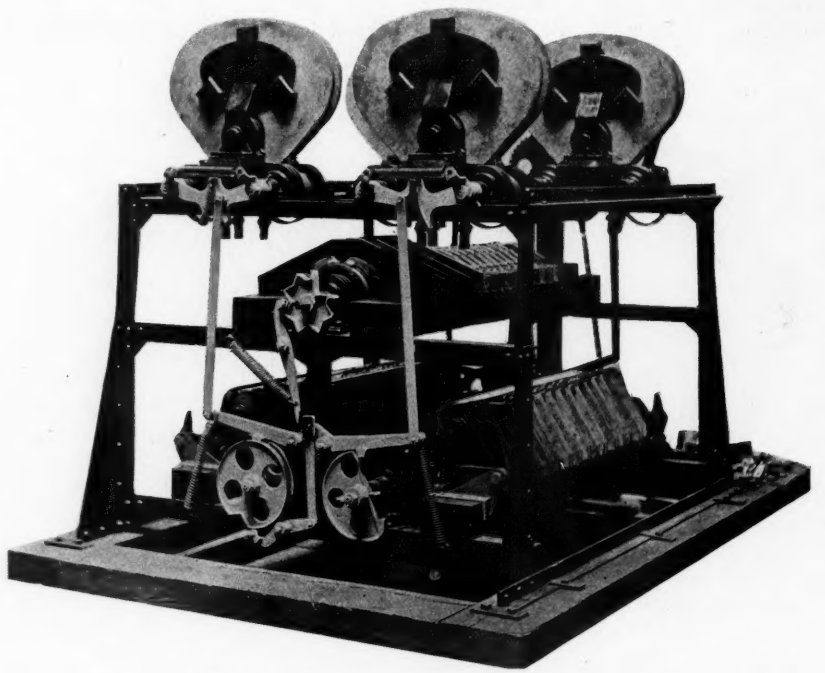

FIG. 9.—MECHANISM OF DRUM CONTROLLER.

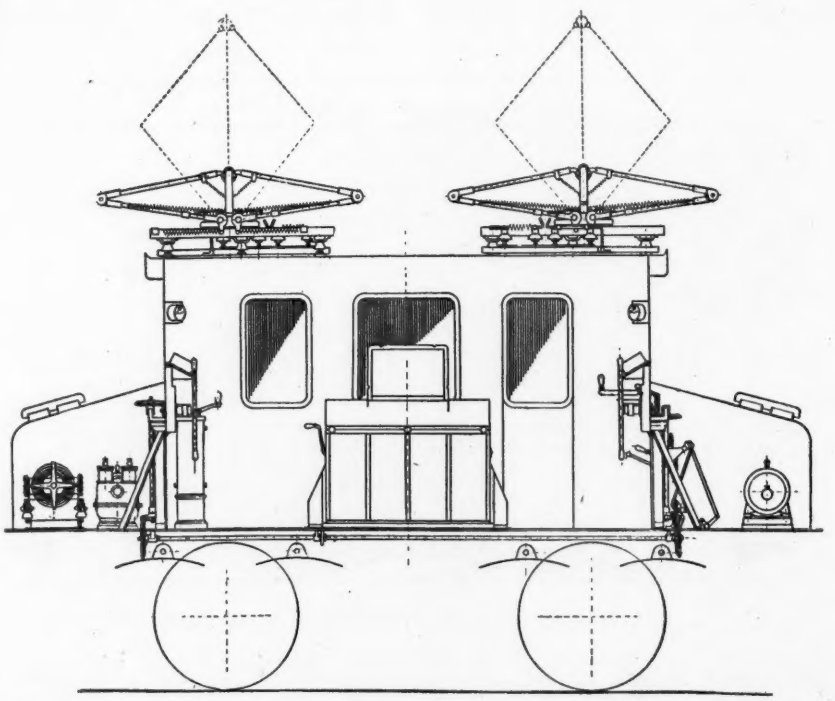

FIG. 11.—ARRANGEMENT OF APPARATUS ON LOCOMOTIVE FOR VIENNA CITY LINES.

in the second end chamber are located the air-compressor with its motor and air tank, also the automatic circuit-breakers and the fuse blocks. Each motorman's post at the ends of the cabin contains a hand-wheel for the main controller, a circuit-reversing handle, a brake-controller, hand brake, automatic circuit-breaker handle, sand box and whistle levers, ammeter, vacuum gauge and a pressure gauge. Recording speed instruments and recording voltmeters and ammeters are also placed in the cabin.

Current for the experimental stretch of road is to be supplied from a substation which the Krizik firm is erecting. It will contain two railway generators designed for 1,500 volts and 225 kilowatts, having a separately excited field winding which is compounded by the use of a series winding. Direct coupled between the two generators is a 700 horse-power, three-phase motor running upon 5,000 volts, and it receives current from the Vienna municipal electric station.

Electrically Worked Gates at a Grade Crossing.

(From Our British Correspondent.)

By the courtesy of C. B. Byles, signal engineer to the Lancashire & Yorkshire Railway, the writer is enabled to give a description of the electrically worked gates of that railway at the grade crossing at Waterloo, near Liverpool, England.

The motor employed is one of two horse-power and running at 1,500 revolutions per minute. The movement of the gates, which are shown in one of the illustrations (Fig. 1), is accomplished in about fifteen seconds. The motor is double-wound, so that the action may be reversed for, respectively, opening and closing the gates. A lever, the normal position of which is midway in the frame, is provided to operate the electrical switches, and a forward movement of this lever applies current to operate the motor in one direction and the reverse movement of the lever applies current for the opposite direction.

In addition to the switches worked by this lever, there is a graduated switch worked by hand; this is provided so that the signalman may regulate the speed of the motor as the gates are worked. When the movement of the gates is completed in either direction the current is cut off automatically by means of switches worked by the gate shaft.

The switch lever in the frame is interlocked with the gate bolt and stops in the usual way, so that the power can not be applied unless the signals are on, nor until the gates have been unbolted.

A clutch is provided worked by a separate lever, and by means of this the gate can be connected to the ordinary gate wheel in the event of the power failing. The motor is connected to the gate-driving gear by means of a friction clutch, the object of which is to prevent the motor and gear from being damaged in the event of the gates encountering any obstruction; the friction gearing can be regulated as required.

The grade crossing at Waterloo is a busy one and the traffic on the railway is heavy. It is anticipated that the average consumption of current per day will amount to about two kilowatt-hours. In Fig. 2, which represents the gearing, the lever in front of the main gearing is a magnetic brake-lever by means of which a brake is applied immediately the power is cut off, thus preventing the gearing traveling after the power has been cut off from the motor.

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FIG. 1.—ELECTRICALLY WORKED GATES, GRADE CROSSING, LANCASHIRE & YORKSHIRE (ENGLAND) RAILWAY.

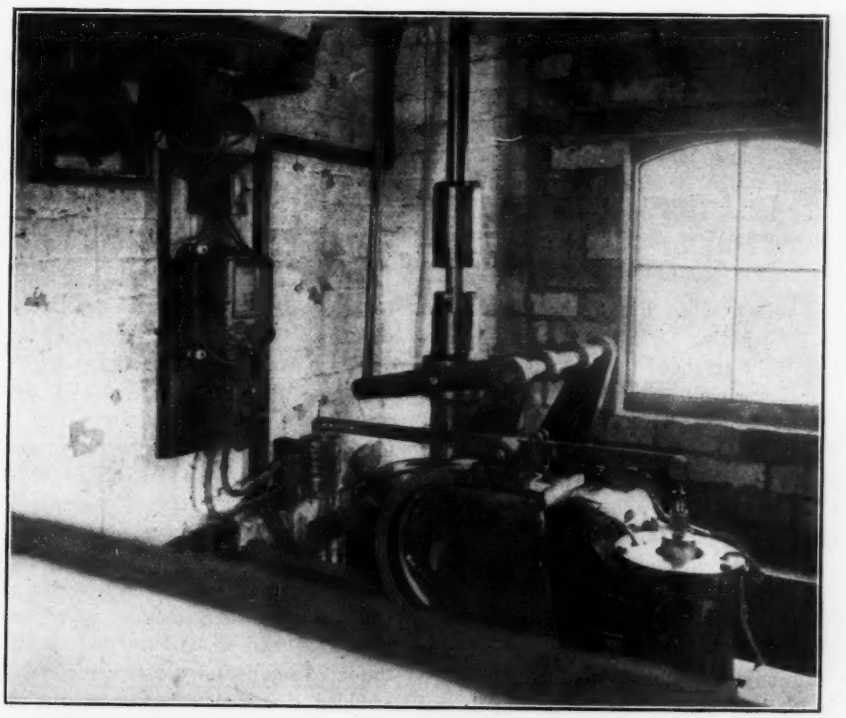


FIG. 2.—ELECTRIC HOIST AND CONTROLLING APPARATUS FOR OPERATING GATES AT GRADE CROSSING.

Instructions for Installing and Operating Alternating-Current Generators.

The following instructions for installation and operation of alternating-current generators are taken from a book recently prepared by the Allis-Chalmers Company, of Milwaukee, for the use of its customers.

All of the generators built by this company belong to the revolving-field class. They are made in five types designed as "belted," "water-wheel," "engine," "fly-wheel," and "turbo."

The mechanical construction varies to some extent with the size and type of generator. In most cases the general arrangement is as shown in Fig. 1. The method of arranging the coils and interconnecting them varies with the number of phases for which the machine is built,

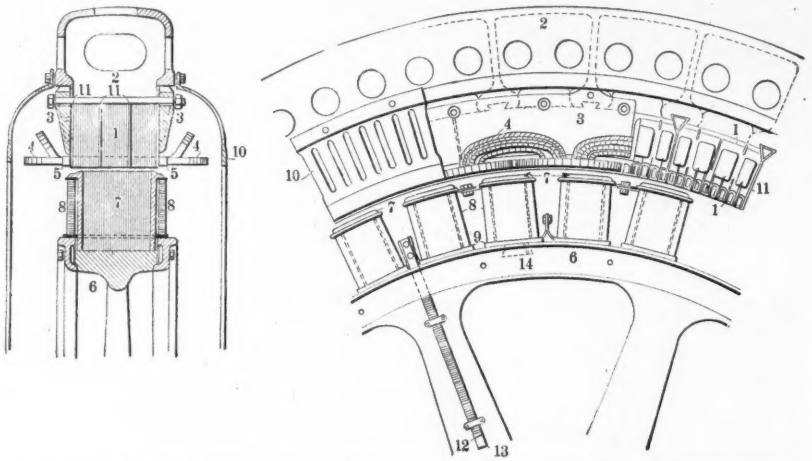


FIG. 1.—SHOWING CONSTRUCTION DETAILS OF ALTERNATING-CURRENT GENERATOR.

1.—Armature Core. 2.—Stator Yoke. 3.—Armature End Head. 4.—Armature Coil. 5.—Armature Coil Stick. 6.—Field Spider. 7.—Field Pole. 8.—Field Coil. 9.—Pole Collar. 10.—Winding Shield. 11.—Ventilating Duct. 12-13.—Field Connections. 14.—Pole Keys.

the voltage, etc. Fig. 2 shows a portion of the winding for a three-phase machine with coils arranged the same as in Fig. 1. For lower voltage machines where it is not necessary to have such high insulation, the winding is frequently of the two-layer type shown in Fig. 3. All the coils are of the same shape and each side occupies only half a slot, one side lying in the upper part of one slot and the other in the lower part of another slot. The field coils of all except some of the smaller machines are of bare copper strip wound on edge with adjacent turns separated by tough insulating paper. In some small machines it is necessary to wind the field coils with square copper wire in order to admit of excitation at 120 volts.

It is desirable to install alternators in a clean dry place where there will be plenty of light and room. Good ventilation is important. The location should provide for sufficient head room to permit taking the machine apart if necessary.

The foundation on which an alternator rests should be firm and substantial, in order to prevent vibration and secure smooth running. Small belted machines below 100 kilowatts can, if necessary, be set on heavy timber supports, but a concrete or brick foundation is recommended whenever possible; all machines above 100 kilowatts must be provided with concrete, brick, or masonry foundations.

The National Board of Fire Underwriters favors the insulation of generators from the ground wherever it is feasible. This is practicable with small belted generators, but with heavy machines or those direct-connected to steam engines or waterwheels complete insulation from the ground is practically impossible, and it is better to ground the frame positively by means of a heavy copper wire.

The generators must be thoroughly protected against lightning and high potentials due to static electricity. The lines should be equipped with lightning arresters, and in cases where high potential static electricity is liable to accumulate, dischargers should be provided to carry it off.

In setting up belted machines the rails should be placed in position, approximately leveled, and wedged up. If the alternator is small and comes completely assembled it can now be set on the rails, carefully leveled, and lined up with the driving pulley.

If the machine is of large size and shipped in two or more parts, place the base on the rails and set the stator in position, first making sure that the planed surfaces on the base and feet of the stator are perfectly clean and oiled to prevent rust. Most of the larger belted machines are arranged so that the stator can be shifted to one side to give access to the field and armature coils, and when the stator is first set on the base it is advis-

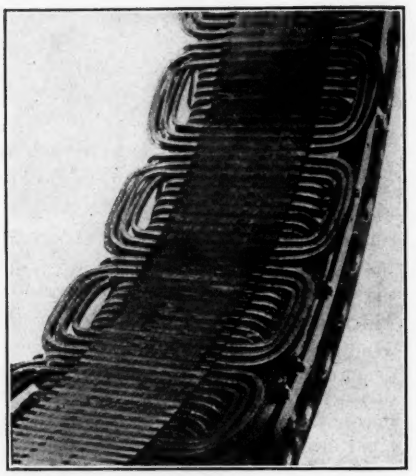


FIG. 2.—CHAIN WINDING.

able to locate it so that it will be to one side of the field when the latter is placed in position. All bearing surfaces should be thoroughly cleaned before the shaft is placed in the bearings. The oil wells should be thoroughly clean. When placing the rotor in position the oil rings must not be allowed to get jammed and bent out of shape; after the rotor has been placed and the caps of the bearing pedestals put in position the base should be bolted down firmly, and the stator

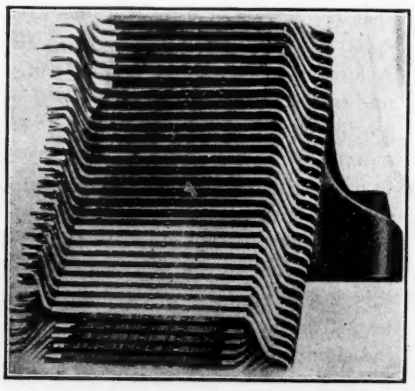


FIG. 3.—TWO-LAYER WINDING.

slid into position over the rotor and bolted in place; if there are any dowel pins in the feet of the stator they should be in place before the cap bolts are screwed down. The bearings should be filled with a good quality of mineral oil. The pulley may then be put on, and the machine lined

up, the foundation bolts tightened and the rails grouted.

The directions regarding belted machines (Fig. 4) apply for the most part to water-wheel alternators (Fig. 5) also, except that the latter have no rails, and the base is set directly on the foundation.

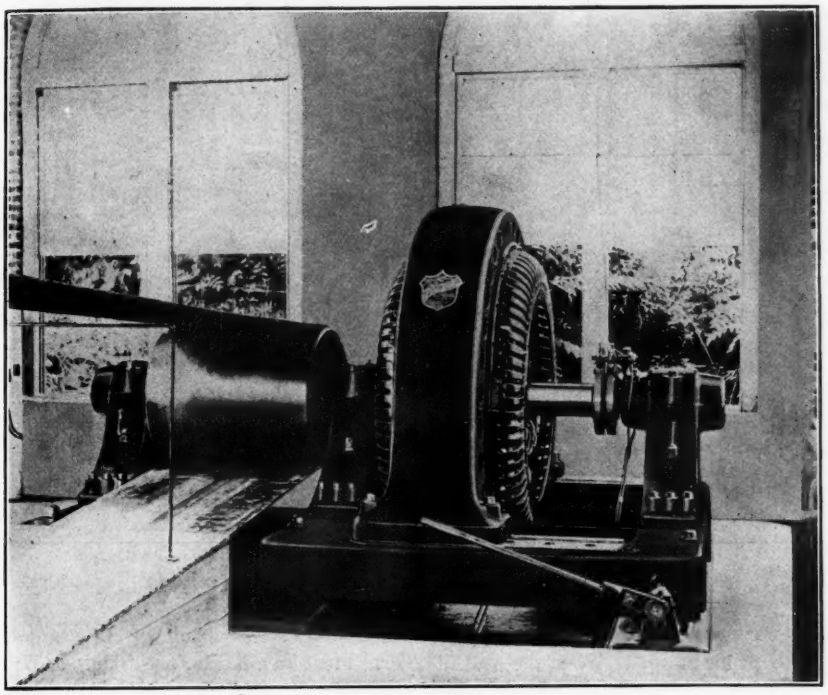


FIG. 4.—BELT-DRIVEN ALTERNATING-CURRENT GENERATOR.

In this case the machine must be lined up accurately with reference to the water-wheel. After lining up by means of wedges under the base, the foundation bolts should be tightened and the base well grouted in. Use plenty of wedges and place them under both inside and outside edges of the base so as to give a firm and even support. In some cases where the water-wheel alternators are of large diameter and run at low speed, no base is provided. The stator and bearing pedestals rest on sole plates bolted to the foundation in the same manner as described for engine-type alternators.

With engine-type alternators (Fig. 6) the stator yoke either rests on an extension of the engine bed, as with some of the smaller machines, coupled to high-speed engines, or on sole plates set on suitable foundations. The stator sole plates are made in two parts, the lower one being bolted to the foundation, while the upper plate is adjustable to facilitate centering the stator with respect to the field.

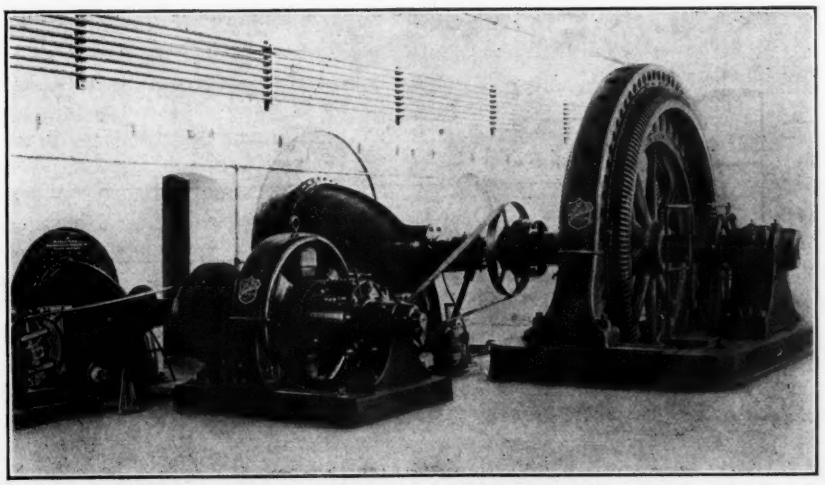


FIG. 5.—WATER-WHEEL-DRIVEN ALTERNATING-CURRENT GENERATOR.

The sole plates should be set in position and the lower half of the stator set in place and leveled approximately by means of the leveling screws in the upper part of the sole plates. In case the stator is arranged to shift sideways on the base or sole plates, set it to one side. Locate the revolving field and engine shaft in bearings. In case the engine shaft has not been pressed into the rotor spider at the factory, special instruction will be sent. Place the top half of the yoke in position and carefully centre the stator with respect to the field by means of the adjusting screws in the feet and sole plates and measure the air-gap between stator face and pole-pieces at a number of points around the circumference; it is very important to have the air-gap uniform.

In large water-wheel and engine-type alternators where the stator is split, it is usually necessary for convenience in shipping to disconnect and remove a few of the stator coils at the two partings in the frame. These must be carefully put in place and properly connected.

In aligning the yoke see that the centre of the armature laminations is in line with the centre of the pole laminations; if they are not in line there will be a side thrust on the shaft.

After the yoke has been finally adjusted insert shims between the upper and lower parts of sole plates so as to take the weight off the leveling screws. Drill and tap holes in the lower sole plate to receive the holding-down bolts for the stator, and bolt the latter securely in place. Fig. 7 shows the construction of adjustable sole plates. A is the lower plate bolted to the foundation, and B is the upper adjustable plate; CC are the leveling screws. The yoke is held in line by spline E, and by means of a bolt threaded into block F the yoke can be shifted in a direction at right angles to the shaft. For sliding the yoke sideways along the sole plate a jack screw H turns in nut K and bears against a plug M that fits into a hole in the stator foot. Parts H, K and M are removed after the stator has been shifted to its final position.

Grout in the sole plates and after the cement has set tighten the foundation bolts and carefully check over the alignment of the machine.

With small alternators the collector rings are mounted in place on the shaft and connected to the field-windings. On large machines, especially engine-type, where there is no shaft, the rings are shipped separately, and in large machines both hub and rings are split so that they can be put in place after the rotor has

been mounted in its bearings. They must be fixed securely in position so as to run true, and connected to leads from the field-winding, making sure that all contacts are clean and bolted up tight.

With large engine-type alternators and also with some of the larger water-wheel machines the brush-holders are supported by a stand bolted to the base or to a bridge fastened to the sole plates. On smaller machines the brush-holder studs are supported by the bearing pedestal.

The brushes should be carefully fitted to the collector rings and the pressure adjusted to give a good contact on the ring.

If a machine has been exposed to low temperature, it should not be unpacked until it has reached the same temperature as that of the room, otherwise a film of moisture may form thereon, due to condensation. After the alternator has been set up it should be dried out by short-circuiting the armature terminals and running the machine with low field excitation sufficient to circulate in the armature a current about twenty-five per cent greater than normal full-load current until it has become thoroughly warmed up and all moisture expelled.

With most of the larger machines a grid resistance is connected to the field switch so that in case the latter is opened the resistance is first connected across the field circuit, thus forming a path through which the induced current thus caused may flow and prevent any abnormal rise in pressure. Fig. 8 shows exciter connections where a grid discharge resistance is used.

When two or more alternators are run in parallel there are certain conditions that must be met in order to secure satisfactory operation. The machine must be in synchronism, and the electromotive forces of the different machines must be in phase. The electromotive forces must be approximately equal, and in order to secure proper division of the load under changes in load conditions, the speed regulation of the prime movers must be alike. To prevent periodic cross currents between machines the variations in angular velocity of the prime movers must be kept within certain limits.

With belted alternators it is important that the pulleys be proportioned so as to make the speeds of the alternators such that they will give exactly the same frequency. If the pulleys are not of the proper size there will be excessive belt slippage or exchange of cross currents between the machines, thus causing fluctuations in voltage. With engine-driven alternators the speed can be varied by adjusting the governor, and there will be no trouble from cross currents provided the angular velocity of the engines does not vary too much, and the engine governors act properly.

When two alternators are running in parallel their output (actual power) depends on the amount of power supplied by their prime movers. When the load increases there is a tendency for the speed to drop slightly and in order for the engine governors to act and admit more steam there must be a slight drop in speed. If the drop in speed does not result in an equal increase in the steam admission of each engine one alternator will be supplied with more power than the other and the load will become unequally divided. Changing the field excitation of the slightly loaded machine will not remedy matters, the only effect being to make a wattless current circulate between the two alternators. The only way to increase the steam admission is by adjusting the engine governor, and to secure equal division of load under all conditions the change in speed for a given change in load must be alike for each engine. When two or more alternators are run in parallel it is advisable to have an indicating wattmeter on each machine, so that the actual load will be indicated. In case wattmeters are not provided the load on each should be adjusted so that the sum of the currents as indicated by the machine ammeters will be a minimum for a given total current supplied to the line. If the sum of the machine currents is much

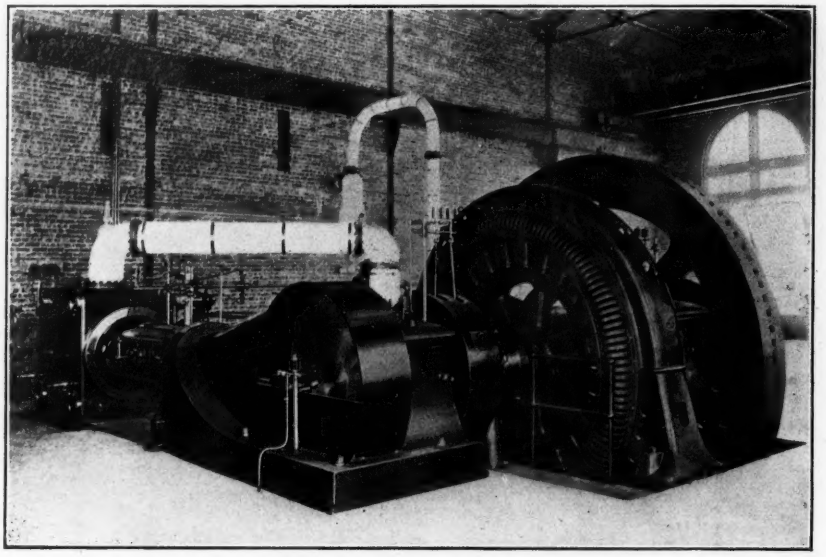


FIG. 6.—ENGINE-DRIVEN ALTERNATING-CURRENT GENERATOR.

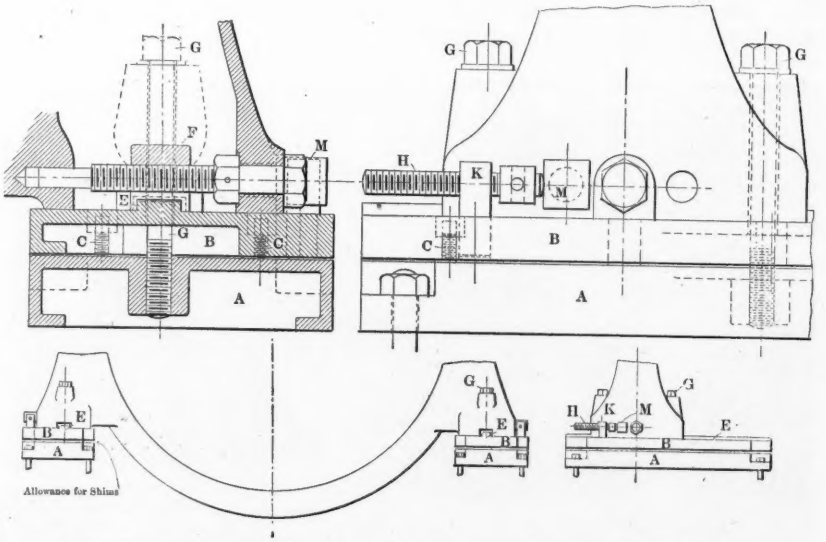


FIG. 7.—ADJUSTABLE SOLE PLATE ALTERNATING-CURRENT GENERATOR.

in excess of the line current it shows that a wattless current is circulating between the machines.

The condition of synchronism is usually indicated either by incandescent lamps, or by a synchronism indicator or synchroscope, the latter now being used in most large installations. A synchroscope gives more accurate indications than lamps and has the additional advantage of showing whether the incoming machine is coming into or going out of phase and how much it is out of phase.

Fig. 9 shows diagrammatically the connections for synchronizing lamps by means of two small transformers. It may happen that the transformers are not wound exactly alike or that the connections have become confused; it is always advisable, therefore, to test the connections to make sure that the lamps are light or dark at synchronism. To test the connections in Fig. 9 disconnect B from generator No. 2 and transfer the connections, without changing their relative positions, to lines 1 and 3 of generator No. 1; A and B will then be connected to the same lines and if the lamps are bright, they will also be bright at synchronism where B is connected to generator No. 2 as shown. If dark lamps are preferred, either the primary or secondary connections of one transformer must be reversed. In synchronizing, bright lamps are to be preferred to dark.

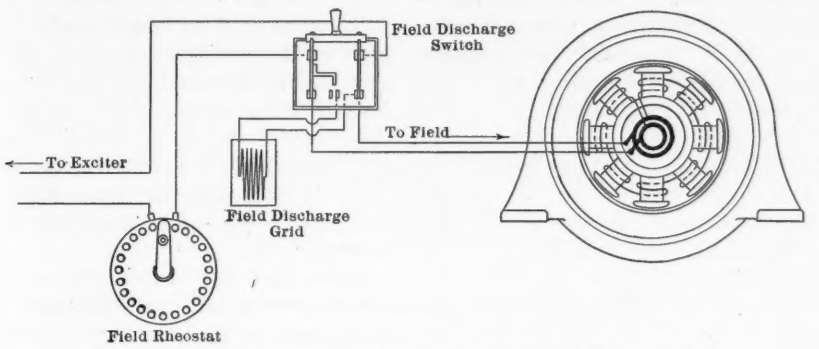


FIG. 8.—EXCITER CONNECTIONS, GRID FIELD DISCHARGE RESISTANCE.

When a polyphase alternator is first connected up it is important to see that all of its phases correspond with those of the bus-bars; if one phase only of a three-phase machine is correct, it does not follow that the other two are correct also. Two of the phases should be tested at the same time by using a pair of auxiliary transformers in addition to the regular synchronizing transformers AB, Fig. 10. Transformer A is connected to the bus-bars and B to the generator. A second pair of transformers CD is connected to one of the other phases, the connections in each case being such that the lamps are bright at synchronism. The connections should be tested as described above to make sure that the polarity of the transformers is correct. With the main switch open and with the generator running at full voltage, both sets of synchronizing lamps should pulsate together. If they do not do so the leads from the generator are incorrectly connected to the generator terminals and should be interchanged so as to make the lamps pulsate together.

When a belted alternator is to be thrown in parallel with another machine the incoming generator should be brought up to speed and the voltage adjusted until it is approximately the same as that of the bus-bars. Adjust the speed until the beats of the synchronizing lamps become very slow, say one beat in two or three seconds, or until the pointer of the synchroscope is moving very slowly. Close the main switch when the lamps indicate synchronism (lights light or dark depending on the connections), or when the pointer of the synchroscope is over the central point or slightly ahead of it. Adjust the field excitation and see that the alternator is supplied with enough power to make it carry its share of the load. In case a number of belted alternators are driven from a common line shaft, the belt of the incoming machine should be slackened, thus introducing enough slip to allow the machine to be synchronized. After the alternator is in step the belt may be tightened and the load gradually applied.

With engine-driven alternators the incoming machine should be given only a small amount of steam until after it is synchronized. The load may then be taken up by admitting more steam. In large plants the engine governor is usually arranged so that it can be controlled electrically from the switchboard and the steam admission varied as desired. If the governor can not be so controlled the steam admission may be regulated at the throttle. Water-wheel governors are also frequently provided with an electrical control device; if not, the gate opening must be controlled by hand to synchronize the machine and adjust the load.

When machines are operated in parallel and one is to be shut down, first reduce the load by throttling the engine or slackening the belt. Then open the main switch, cut in resistance in field of alternator to reduce field current, and open the field switch.

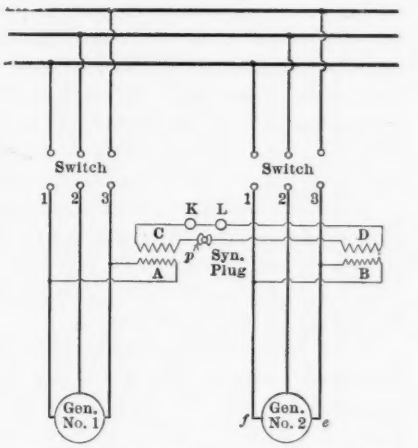


FIG. 9.—SHOWING DIAGRAMMATICALLY CONNECTIONS FOR SYNCHRONIZING LAMPS.

Alternators must be properly attended to. No dirt, copper or carbon dust should be allowed to accumulate on or near the windings. It is advisable to give the armature coils and connections a coat of insulating varnish occasionally.

Keep the collector rings lubricated with a small quantity of vaseline and see that the brushes make good contact with the rings.

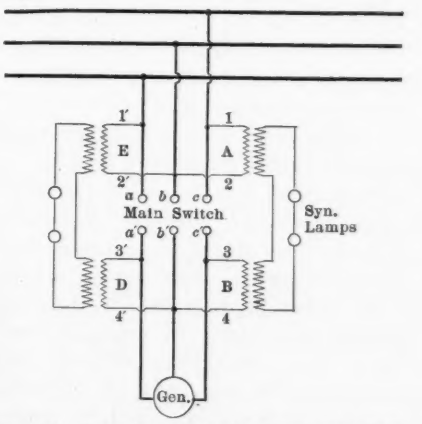


FIG. 10.—SHOWING DIAGRAMMATICALLY CONNECTIONS FOR SYNCHRONIZING LAMPS.

Never open the field circuits suddenly while current is flowing, and see that both main and field switches are open when the machine is not running.

Never throw the machines in parallel when they are out of synchronism, the excessive rush of current throws heavy strains on the engines and generators and may cause considerable damage.

Check the air-gap between stator and rotor now and then, and if it is found to be uneven, realign the machine. This applies particularly to engine-type generators.

ON THE SUBSTITUTION OF THE ELECTRIC MOTOR FOR THE STEAM LOCOMOTIVE.[1]

BY LEWIS B. STILLWELL AND HENRY ST. CLAIR PUTNAM.

The purpose of this paper is fourfold: first, to record certain facts relative to heavy electric traction which have been established by experience; second, to present calculations of relative costs of steam and electric traction in railway service based upon these facts; third, to point out the transcendent importance of standardizing electric-railway traction equipment as rapidly as may be consistent with progress; and fourth, to raise the question whether a frequency of twenty-five cycles per second or fifteen cycles per second should be adopted in railway operation by alternating-current motors.

Three-phase and single-phase alternating-current railway motors are now developed to a point where they fairly challenge the steam locomotive, even in long-haul freight service, in which class of work the direct-current motor hitherto has found itself unable to compete with success. The direct-current motor has demonstrated impressively, and upon a large scale, its superiority to the steam locomotive, not only in operating single cars and short trains on lines of moderate length, but also in frequent and heavy passenger service in which the length of train is limited only by the length of station platform, while the motive-power equipment far exceeds in power developed the limits hitherto established in steam passenger service.

On the Valtellina line and through the Simplon tunnel seventy-ton electric locomotives with three-phase motor equipment, capable of developing a draw-bar pull of 28,000 pounds, have displaced the steam locomotive, with results showing both marked improvement in service and substantial economy in operating costs. In the New York subway, eight-car trains weighing 320 tons are in operation, equipped with motors developing during acceleration a tractive effort equivalent to a draw-bar pull of 55,000 pounds.

The heaviest passenger locomotive used on the Erie system weighs, exclusive of tender, 206,000 pounds, of which 55.8 per cent, or 115,000 pounds, is effective on drivers. Assuming the adhesion to be twenty per cent, such a locomotive exerts a draw-bar pull of 23,000 pounds. The motors of the eight-car electric trains of the New York subway, therefore, exert a tractive effort equivalent to more than twice the draw-bar pull of this locomotive.

Managers and engineers of railways using steam are considering the possibilities of electricity. Naturally, the problem usually presents itself in reference to particular cases in which special conditions emphasize the advantages of electric traction; but a point has been reached in the development of electric-railway equipment where it is evident that no absolute and permanent limits beyond which the motor may not go can be fixed; and it is not unreasonable to consider the possibilities of the electric motor not only in passenger service, but also in freight service, not only in the operation of railway terminals, but also for the operation of railway divisions and even for trunk lines. The answer to the question: "Will it pay to electrify?" involves consideration of both relative earnings and relative cost of operation.

PASSENGER SERVICE FACTORS CONTRIBUTING TO INCREASED EARNING POWER.

The more important considerations which affect gross earnings are:

1. Frequency of service.
2. Speed.
3. General comfort of passengers.
4. Safety.
5. Reliability of service.
6. Increased capacity of line.
7. Frequency of stops.
8. Convenient establishment of feeder lines.

1. Frequency of Service—The motor-driven interurban car operating upon scores of lines in competition with steam railway service has convincingly demonstrated its ability not only to attract business from competing steam lines but also to create new business.

2. Speed—The possibilities of operating by electricity at speeds exceeding the maximum which can be obtained safely in steam operation, owing to the elimination of unbalanced reciprocating parts of the locomotive, is well known. It was strikingly illustrated in the Berlin-Zossen trials by the attainment of a speed exceeding 130 miles an hour. These tests demonstrated the ability of electric equipment to operate at a sustained speed more than twice as great as that of our fastest express trains on runs of any considerable length, and exceeding by about fifty per cent the maximum which can be attained even for a short distance by the steam locomotive with a reasonable degree of safety. Even at speeds at which steam locomotives may be operated without great danger of leaving the track, as a result of the effect of unbalanced reciprocating parts, electric engines are far better able to maintain speed while drawing heavy trains.

3. General Comfort of Passengers—The great advantages of electric traction in respect to comfort of passengers are well known. Cleanliness and improved ventilation made possible by the elimination of smoke and cinders; lighting practically without heat and at low cost by a system which makes it easy to place lamps in any desired location, and heating apparatus effectively and conveniently controlled, are factors of very great importance in building up passenger business under conditions of competition. In operating through tunnels, ventilated with difficulty, the electric motor, in eliminating smoke and the gases of combustion, possesses an advantage which is frequently controlling.

4. Safety—So much has been said and printed in the daily press regarding the alleged dangers of electric traction that it is well to place on record here a statement of the considerations which inevitably lead to the conclusion that electric traction, if the equipment be properly designed and installed, is essentially and materially safer, so far as the traveling public is concerned, than steam traction. The more important of these considerations are:

a. The fact that in case of a rear-end collision, which is perhaps the most frequent form of accident experienced in the operation of our railway systems, the energy which propels the electric train can be shut off generally with great promptness. On the other hand, the steam locomotive carrying in its fire-box from 1,500 to 2,000 pounds of coal heated to incandescence, almost invariably sets fire to any broken cars, or other combustible material with which it comes in contact. Where the electric supply to trains is obtained at low potential from a third rail, the risk of short-circuit, which may result in fire if the cars be not fireproof, is greater than it is in the case of overhead construction, even when the voltage employed in the latter case is very high. In fact, in the latter case it may be said that risk from the physiological effects of the current or from fire resulting from short-circuit is practically eliminated, except perhaps in tunnels of very limited clearance.

b. The elimination of the boiler carrying steam at high pressure, also means the removal of an element of risk which in many railroad accidents has destroyed life.

c. The absence of smoke in tunnels,

[1] A paper presented at the 213th meeting of the American Institute of Electrical Engineers, New York, January 25. Condensed.

and consequent ability to see signals clearly at all times, constitutes an advantage of the utmost importance for electric operation.

d. The electric heater affords opportunity not only for ideal control of temperature of the cars but almost absolutely eliminates risk of life.

e. The elimination of the gas tank and the oil lamp used for lighting in steam traction, and the substitution of electric lighting, also implies a material gain in safety.

f. The danger of derailment in the case of the electric locomotive is far less than in the case of the steam locomotive, by reason of the elimination of unbalanced reciprocating parts.

g. The electrification of railways where high-speed passenger traffic is involved, affords opportunity for improved methods of protecting trains by signal systems, automatic or other.

h. The ability to cut off power at will from a given section and therefore from trains operating upon that section under certain conditions, may be availed of to prevent accidents.

As against the considerations above referred to, the addition to the permanent way equipment of an electric conductor conveying power to trains imposes in the former case a material risk not involved in the latter. If the power be supplied through a third rail, a guard should be used whenever possible to prevent accidental contact with the rail by employés or by others walking upon or crossing the track. Several effective forms of guard are available, of which at least one has been in service upon a convincing scale for five years.

5. Reliability of Train Service—Interesting evidence in respect to the relative reliability of steam locomotives, and of electric motors carried upon cars and controlled by the multiple-unit system of train-control, is derived from the official records of the transportation department of the Manhattan Division of the Interborough Rapid Transit system of New York. Upon the elevated lines, steam locomotives were used from the inauguration of the first constituent line of the ultimate system in 1872 until 1902, during which year and a part of the following year, electric equipment was gradually substituted. The locomotives were operated under exceptionally favorable conditions, were not overloaded, were of simple construction, and admirably maintained. The electric equipment that succeeded them is operating trains which average 5.3 cars as against 3.8 cars in the days of steam operation. The average speed is materially higher.

Accurate record is kept of the duration of every delay in the operation of the trains. The results for the months November, 1900, to March, 1901, when steam was used, and the corresponding months of the years 1905-6 under conditions of electric operation, illustrate in a striking manner the marked gain in reliability of service which has resulted from the adoption of electricity. For the five months of steam operation the aggregate car-mileage was 18,527,773 miles, and the aggregate delay 8,258 train-minutes. The car-mileage per train-minute delay was 2,243.

For the corresponding period of electric operation, five years later, the car-mileage was 25,482,081, the aggregate train-minutes' delay 5,970 and the car-mileage per train-minute delay was 4,268.

6. Increased Capacity of Line—Electric traction, where electric locomotives are used, eliminates dead weight by abolishing the tender and facilitates construction under which practically the entire weight of the locomotive is carried upon the drivers. Where the motors are mounted directly upon trucks of cars constituting the train, the best results are obtained. This increase in weight available for adhesion, in conjunction with the characteristics of the electric motor, makes it possible to attain electric service rates of acceleration altogether impracticable in steam service; consequently trains in passenger service where short headway is desirable can follow each other at shorter intervals than is feasible where steam motive power equipment is employed.

In operation of freight trains, if it should ever become practicable to distribute electric locomotives throughout the length of the train and operate them by multiple-unit control, trains of length far beyond present limits could be operated.

7. Frequency of Stops—The interurban electric line competing with the steam railroad for traffic between two cities possesses great advantage in the collection and distribution of passengers, from the ability of its cars to stop at any street intersection or other convenient point, instead of receiving and discharging passengers at a single railway station in each town.

8. Convenient Establishment of Feeder Lines—A natural development, which during the last five years has been very rapid, is found in the use of comparatively short electric trolley lines in connection with steam express service for long-distance runs. This method of utilizing the advantage of local electric lines by the companies operating trunk line systems is eminently wise. However, were the trunk line systems to utilize electricity for through traffic, the extension and systematic improvement of local feeders would be facilitated, because power developed in large amount, as for the operation of heavy through traffic, is produced at low cost per unit, and because of the possibility of attaching cars or short trains arriving on local lines to through trains at points of junction.

ILLUSTRATIONS OF PASSENGER BUSINESS DEVELOPED BY INTERURBAN ELECTRIC LINES.

In a very comprehensive paper presented by J. G. White before the International Engineering Congress at St. Louis in 1904, the following striking illustrations of the advantages of frequent service are given:

"Cleveland-Oberlin Line—These cities are thirty-four miles apart. The competitors for passenger traffic between these cities and intermediate points are the Lake Shore & Michigan Southern Railroad (steam) and the Cleveland, Elyria & Western (electric). In 1895 the total number of passengers carried by the steam railway between these cities and intermediate points was 203,014. This total decreased gradually after the competing electric line was opened to a minimum in 1899 of 71,755, from which it gradually recovered in 1902 to 91,761, but during this same year the electric road carried a total of about 3,000,000.

"Cleveland-Plainesville Line — These cities are thirty-nine miles apart. The competitors for passenger traffic are the Lake Shore (steam) and the Cleveland-Plainesville and Eastern Railway (electric). In 1895 the steam road carried between the terminals and intermediate points 199,292 passengers, but in 1902 it carried only 28,708 passengers, while the electric system carried 1,537,754 passengers.

"Cleveland-Lorain Line—These cities are twenty-six miles apart. Competitors are the New York, Chicago & St. Louis Railroad (steam) and the Lake Shore (electric). In 1895 the steam road carried 42,526 passengers but in 1902 it carried only 9,795 passengers, the electric road in the same year carrying 3,896,902 passengers."

The Lackawanna & Wyoming Valley Railway Company, operating a double-track system between the cities of Scranton and Wilkes-Barre, Pa., carried, during the four months ending October, 1906,

1,396,833 passengers. This railway, eighteen miles in length, competes with two double-track steam railways having excellent terminals in both cities, and with a third double-track steam railway having an equally good terminal in Scranton, but a less favorably located terminal at the Wilkes-Barre end of the line.

A study of the transportation statistics of New York city, particularly during the last decade, is not only of great local interest, but is instructive as illustrating the effect of improvement in transit facilities upon gross receipts. Comparing the Manhattan Elevated Railway for the year 1893 with the same system for the year 1899, a decrease of twenty-one per cent in paid fares is found. During the same period the paid fares of surface lines, which meanwhile in large degree had adopted electric operation, increased by forty-three per cent. The decrease in business on the elevated lines was not due to any decrease in the service, as the car-mileage operated increased steadily during this period. The inference is that the diversion of traffic to the surface lines was a direct result of the improved service offered by the latter.

During the year ending June 30, 1901, the last fiscal year of steam operation on the elevated lines, the Manhattan system collected 190,045,741 fares. The surface lines collected 388,108,794 fares. During the year ending June 30, 1904, the Manhattan system, now operated by electricity, collected 286,634,195 fares, an increase of fifty per cent, while the surface lines collected 419,423,092, an increase of about eight per cent. In the following year, 1904, the subway began operation, and both elevated and surface lines recorded a decrease in fares collected.

Notwithstanding the very rapid increase in population of the Borough of Manhattan and The Bronx from 1890 to 1905, the paid fares collected by the several transportation systems have increased still more rapidly.

COMPARATIVE COSTS OF OPERATION.

As the standard with which to compare our estimate of cost of electric operation, we have adopted the grand average results obtained in operation by steam locomotives upon the existing railways of the United States, as set forth in the report of Statistics of Railways for 1904 compiled by the Interstate Commerce Commission, and proof-sheets of the report of the commission for the year 1905. The estimated costs of electric operation being approximately determined as compared with the grand averages obtaining in steam railroad practice in this country, the work of determining, for any given case, the relative advantages and disadvantages of steam and electric operation will perhaps be facilitated. In estimating operating expenses of electric equipment, we have based conclusions upon results obtained in practice so far as we possess the necessary data.

The substitution of electric for steam equipment involves a large investment in power plant, and in electric conductors and apparatus for conveying power from the power plant to the moving trains. The distributing system for alternating-current equipment, which is the only class of equipment deserving serious consideration in connection with the general problem which we are discussing, comprises an addition to permanent way equipment in the form of overhead construction and electrical conductors conveying power from the power-house to the trolley or conductor which is carried above the track. At the present time, the limit of potential generally adopted in this country in constructing alternating-current dynamos is 11,000 volts. Where this voltage is generated, and the distance from the power-house to the section of railroad to be electrified does not exceed twenty-five or thirty miles, step-up and step-down transformers are unnecessary. For greater distances, higher potentials are used upon the feeder circuits between power-house and trolley, transformers for increasing the generated potential being installed in the power-house, and transformers for lowering the potential to that selected for the trolley; *e. g.*, 11,000 volts, being located in suitable transformer houses at intervals of from thirty to fifty miles, depending chiefly upon density of traffic.

For the trolley, a potential of 11,000 volts is suitable and can be adequately insulated. The mechanical support for the trolley comprises, preferably steel poles with brackets or light steel bridges spanning the track.

The cost of the power plant and distributing system are properly chargeable to capital account.

Our estimates are based upon the assumption that single-phase alternating-current equipment is used; that the trolley potential is 11,000 volts; that each power-house supplies railway line to a distance of 150 miles in each direction, the feeder potential employed being 60,000 volts; that the overhead construction is first-class in every respect, and steel bridges and field poles set in concrete being exclusively used for the support of both trolley conductors and feeders.[1]

As regards equipment of the rolling stock, it is the general practice of our railways to charge against operating expenses all new equipment purchased to replace that which has been worn out in service. In the adoption of electricity, it would seem that this method might be followed in general by our more important railway systems, the substitution of electric equipment beginning naturally upon those parts of the system where the resulting advantages are maximum. In other words, worn-out locomotives, etc., on such a system might be replaced by electric equipment and the cost of the equipment charged against operation, just as the cost of new steam locomotives otherwise required would be charged against operation. The cost of these new locomotives under steam operation would be charged against "Repairs and renewals of locomotives," and it would seem that their value expended for electric equipment to replace them might be similarly charged. In addition to the purchase of new locomotives to replace those worn out in service, our railroads are compelled from year to year, by the growth of their business, to purchase additional locomotives and other rolling equipment. While these are usually charged against capital account in one form or another, it may be pointed out that any method of financing their cost which may be adopted is equally applicable to electric locomotives.

In cases where the initial substitution of electricity is on a large scale, as compared with the total rolling stock equipment of the railroad making the change, it is probable that a part if not all of the cost of electric rolling stock equipment will generally be charged to capital account.

The grand average costs of steam operation in the United States for the years 1901-1905, are set forth in the following table. Many of the items included in this tabulation vary between wide limits in the practice of different railroads.

MAINTENANCE OF WAY AND STRUCTURES.

Under the general heading, "Maintenance of Way and Structures," item No. 1, "Repairs of Roadway," if charged at all should show some reduction under conditions of electric operation, but obviously no material change is to be expected. We assume, therefore, that this item, amount-

[1] In assuming the use of the single-phase system we are not condemning other systems. The three-phase system has not received from American engineers in general that degree of consideration which its possibilities and demonstrated advantages justify. Its use, at least on mountain-grade divisions, can be supported by very strong arguments.

ing to 10.818 per cent of total operating expenses, will remain unchanged.

The items, "Renewals of rails," "Renewals of ties," and "Repairs and renewals of bridges and culverts," may be conveniently grouped. In the aggregate, these on the average steam operated railroad amount to 6.33 per cent of the total cost of operation. If the electric locomotive be substituted for the steam locomotive, it is safe to predict that this group of items of expense will be reduced. From the best study which we have been able to make of the detailed factors comprised under these three items of the classification, it would seem that under electric operation they should be reduced about one-fourth; in other words, they should approximate five per cent of the total operating expenses.

The cost of track maintenance is increased by reason of the electric bonding of the rails. This bonding, including the cost of special bonds necessary where an automatic track signal system is used, will cost about $500 per mile under average conditions. Its cost of inspection and maintenance should not exceed $50 per mile of single track per annum.

The annual cost of "Renewals of rails," "Renewals of ties," and "Repairs and renewals of bridges and culverts," averages, in the United States, $400 per mile of track, which as above stated, is 6.633 per cent of average operating expenses, under steam operation, and for equal trains, as we have estimated, five per cent for electric operation. The effect of track bonding would increase the items under consideration by about one-eighth, which is equivalent to an increase of 0.8 per cent in operating expenses. To avoid possible confusion, we include the cost of "Repairs and renewals of track bonding," as a separate item in the column, "Estimated cost of operation by electricity."

Item 5, Table I, "Repairs and renewals of fences, road-crossings, signs and cattle-guards," will not be changed by the adoption of electricity.

Item 6, "Repairs and renewals of buildings and fixtures," includes repairs and renewals of engine houses and shops, also water tanks and coal-handling apparatus. Under electric operation, it is evident that this item would be materially reduced.

TABLE I.

Item	Amount 1905	Per cent. 1905	1904	1903	1902	1901	Average Five Years	Estimated Cost of operation by Electricity
Maintenance of Way and Structures	274,415,279	19.784	19.519	21 185	22.255	22.272	21.003	22.354
1. Repairs of roadway	144,161,701	10.393	30.348	11.093	11.331	10.294	10.818	10.818
2. Renewals of rails	18,259,022	1.316	1.298	1.386	1.521	1 676	1.439	
3. Renewals of ties	36,856,864	2.657	2.519	2.487	2.838	3.140	2.728	5.00
4. Repairs and renewals of bridges and culverts	32,166,990	2.319	2.228	2.461	2.593	2.730	2.466	
5. Repairs and renewals of fences, road-crossings, signs and cattle-guards	6,179,686	0.446	0 437	0.527	0.625	0.598	0.527	0.527
6. Repairs and renewals of buildings and fixtures	29,320,204	2.114	2.147	2.590	2 562	2.417	2.366	1.300
7. Repairs and renewals of docks and wharves	2,883,274	0.208	0 209	0.235	0 220	0.283	0.231	0.231
8. Repairs and renewals of telegraph	2,374,932	0.171	0 179	0.165	0.173	0.158	0.169	0.169
9. Stationery and printing	383,158	0.028	0.029	0.032	0.031	0 029	0.030	0.030
10. Other expenses	1,829,448	0.132	0.125	0 209	0.361	0.317	0.229	0.229
Repairs and renewals of track bonding								0.800
Repairs and renewals of overhead construction								3.250

"Repairs and renewals of locomotives"—It is conservative to say that for the operation of a given train-mileage, under the average conditions of railway service in this country, the number of electric locomotives required should not exceed one-half the number of steam locomotives now used. The reduction in the number of locomotives implies, of course, a reduction in the cost of repairs and renewals of engine house and shops, and taking this into account, in connection with the elimination of water tanks and coal-handling apparatus, distributed along the line, this item will be reduced from 2.366 per cent to about 1.3 per cent of the total annual operating expenses.

Item 7, "Repairs and renewals of docks and wharves," obviously will not be affected.

Item 8, "Repairs and renewals of telegraph." It is probable that this item will be somewhat increased in general where electric operation is adopted. The effect upon the operating expenses, however, is so slight as to be practically negligible in our consideration of the general problems of comparative expenses of steam and electric service.

Item 9, "Stationary and printing," will not be changed.

Item 10, "Other expenses," we may assume will not be affected.

Under the general heading, "Maintenance of ways and structures," the classified statement of operating expenses of a railroad electrically equipped includes the following items in addition to the foregoing:

a. "Repairs and renewals of track bonding."

This has been referred to in our discussion of items 2, 3 and 4, and it is included in our tabulated statement as a separate item amounting to 0.8 per cent of operating expenses.

b. "Repairs and renewals of overhead or third-rail construction."

From detailed calculations of the cost of high-class overhead construction, where two tracks are to be equipped the cost of overhead construction is approximately $10,300 per mile. This includes trolley conductors equivalent to No. 4/0 wire B. & S. Gauge, insulated for 11,000 volts alternating, and supported by steel cables, carried by substantial steel bridges set in concrete, and spanning the tracks. For single-track work using steel poles and brackets and catenary support, the cost closely approximates $4,800 a mile.

Of the total line mileage of the United States in 1905, amounting to 216,974 miles, approximately 0.4 are in double track, including yards and sidings for single-track lines, and 0.6 are single track.

The grand average cost of overhead steel construction of the type considered closely approximates $5,000 per mile of track. In this case, our estimate of the annual cost of "Repairs and renewals of overhead construction" can not rest directly upon actual experience, since practically no overhead construction of this character is in use under the conditions of railway service. We may, however, base conclusions which should be reasonably correct upon consideration of first-class overhead trolley construction.

Light steel bridges, set in concrete, subject to the comparatively slight strains involved in supporting the light conductors

required, should last almost indefinitely if kept properly painted. The absence of smoke and gases from locomotives favors their long life. The cost of these steel bridges and poles is a large part of the overhead construction.

The wear of the trolley wire will depend upon density of traffic, but its original cost is only $700 a mile, and judging from the experience of ordinary trolley lines and the results obtained on the Valtellina, its life should be long.

The steel catenary cables supporting the conductor being well galvanized should last many years without renewals.

Breakage of insulators, such as are now available, will not constitute a large item of expense.

As regards life of steel structures, it is instructive to note the fact that much of the structure of the Manhattan Elevated lines still in use is more than thirty years of age, and is apparently unimpaired notwithstanding the heavy and frequent traffic which it has carried and still carries.

It is probable that the amount which should be allowed for "Repairs and renewals of overhead construction" should not exceed $150 per mile of track per annum. This is equivalent to $210 per mile of line per annum, the average ratio of track mileage to line-mileage being 1.4 to one.

The increase in operating expenses due to this item is about 3.25 per cent, the average operating expenses per line-mile in the United States for the year 1905 being $6,451.00.

It is, of course, possible to erect a much cheaper form of construction if wood poles be used. The annual effect upon operating expenses with this type of construction as an average figure may be expected to approximate 2.5 per cent.

(To be continued.)

Ten-Thousand-Horse-Power Electric Plant for the Long Acre Electric Light and Power Company.

It was announced during the week that contracts had been placed for a 10,000-horse-power electric plant to be built on Forty-second street, west of Tenth avenue, New York city, for the Long Acre Electric Light and Power Company. The order for turbines, it is stated, has been given to the Wilkinson Steam Turbine Company, of Birmingham, Ala., and calls for the delivery of this part of the plant in four months. It is said that work will be begun immediately on the building.

A recent decision of the Supreme Court upheld the claims of the Long Acre company to rights in the ducts of the Consolidated Telegraph and Electric Subway Company through Forty-second street and up Broadway. The new plant, however, would be altogether beyond the capacity of this distribution system, and John C. Sheehan, president of the Manhattan Transit Company, the owner of the Long Acre Electric Light and Power Company, states that the plans for a large plant will be consummated in anticipation of an acknowledgment of the company's rights to space in the conduits all over the city.

The Long Acre Electric Light and Power Company was incorporated by several theatrical men and associates, and acquired a franchise granted twenty years ago by the board of aldermen to the American Electrical Manufacturing Company. This company is long since defunct. The franchise owned by the American company authorized the grantee to lay overhead or underground wires throughout the city streets for the conveyance of electricity. The company was incorporated with a capital of $50,000, and Alfred Hayman, William Harris, William W. Walters, Henry B. Harris and Frank McKee were the incorporators. Since then the company has been absorbed by the Manhattan Transit Company, in which John C. Sheehan and associates are the prime movers. According to a statement issued recently by representatives of the Manhattan Transit Company, Edgar Van Etten, vice-president of the New York Central & Hudson River Railroad, is a director of the Manhattan company, and is about to be elected its president. Among the other directors are William J. Clark, manager of the foreign department of the General Electric Company; William H. Lamprecht, of Lamprecht Brothers, bankers, Cleveland; G. Tracy Rogers, John C. Sheehan and William Harris. Under its charter the Long Acre company is authorized to erect a plant and lay the necessary wires and other conductors in the district bounded by Fifth avenue, Thirty-third street, the North river and Fifty-ninth street.

The American Electrical Manufacturing Company transferred its franchise in 1888, without having made any use of it, to Frederick E. Townsend. He, in turn, transferred this franchise in 1889 to the American Illuminating Company, which company erected a plant and generated and sold electricity by means of overhead wires until the Consolidated company's subway conduits were completed, when the city authorities stepped in and tore down all of the American company's overhead wires. This action forced the American company into the hands of a receiver. The franchise was sold to Martin Minturn in 1897, who, in turn, on March 1 last assigned all his rights and interest in it to the Long Acre Electric Light and Power Company.

The Consolidated Telegraph and Electric Subway Company, under a contract made with the city in 1886, and subsequently ratified by the legislature, is in control of the subway conduits for the conveyance of electricity through the public streets. By its contract, however, it is bound to allot suitable space to any other electric company which has legal power to furnish electricity, receiving a rental in return of $1,000 a year for each mile of duct. The Long Acre company's application for space in these conduits has been denied, the contention being that the Long Acre company did not have the necessary legal power to sell electricity. Justice Dowling granted a peremptory mandamus ordering the Consolidated to set aside the necessary space. From this the Consolidated appealed. The matter was then taken to the Court of Appeals, and a decision rendered by a divided court, three justices affirming the decision of Justice Dowling in the Supreme Court last October, and two justices dissenting.

New York Section of the Illuminating Engineering Society.

On Friday, February 8, a meeting of the New York section of the Illuminating Engineering Society will be held at the Edison Auditorium, 44 West Twenty-sixth street, New York city, for the election of officers of the New York section for the ensuing year. Thomas J. Lytle, Jr., of the Welsbach Company, Gloucester, N. J., will present a paper on "The Photometry of Incandescent Gas Lamps."

Lackawanna Railroad to Electrify.

It is announced that improvements in its suburban service involving the installation of electricity as a motive power will soon be made by the Lackawanna Railroad. A system similar to that recently put in operation by the New York, New Haven & Hartford Railroad is to be installed on the road from New York to Morristown, N. J., and on the Montclair (N. J.) branch.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

DISCUSSION ON THE SUBSTITUTION OF THE ELECTRIC FOR THE STEAM LOCOMOTIVE.

The 213th meeting of the American Institute of Electrical Engineers was held in the auditorium of the Engineers' Building, West Thirty-ninth street, New York city, Friday evening, January 25, 1907. This was the first meeting of the institute to be held in the new building, and, as the paper to be read was of general interest, invitations had been extended to the members of the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the New York Electrical Society, the New York Railroad Club and the Transportation Club to attend.

The paper of the evening was entitled, "On the Substitution of the Electric Motor for the Steam Locomotive," by Lewis B. Stillwell and Henry St. Clair Putnam.

It was presented in abstract by Mr. Stillwell and will be found, somewhat condensed on another page of this issue.

Opening the discussion, Frank J. Sprague said the authors had given an interesting résumé of statistical information based almost entirely upon direct-current operation; they had generalized the features of operation of the steam railroads of the United States; and on these as a basis, they proposed as a standard for electric railway operation, 11,000 volts, alternating current at fifteen cycles. Mr. Sprague does not accept this conclusion and believes that the 600-volt, 1,200-volt or 1,500-volt direct-current motors will still be in service ten years from now. The Pennsylvania, from New York to Philadelphia, may be taken as a typical trunk line division. He believed that if this line were called upon to be electrified to-day, it would not be overhead, single-phase alternating current either twenty-five or fifteen cycles, but direct current. He ventured this prophecy—that on a large number of the lines which can by any stretch of imagination be considered as subject to a reasonable prospect of electrification, 1,200 or 1,500 volts direct current will, on any present development known, give better results in every way than alternating current at fifteen or twenty-five cycles, with an overhead system.

B. G. Lamme said that on account of considering the total amount involved in the electrification of the railroads of this country, $1,500,000,000, that the problem is big enough to call for a frequency which is most suitable for the work. The question is whether that should be twenty-five cycles or something lower. About three years ago he presented a paper to the institute, describing a single-phase railway system. The frequency given was sixteen and two-thirds cycles, a ratio of two to three to the standard frequency of twenty-five. There was considerable opposition to the use of this low frequency and commercial conditions forced the adoption of twenty-five cycles. He advocated, however, strongly, the use of lower frequency when it came to heavier work, and still advocates it. The reasons which can be given are the greater output one can get from a given motor. For instance, with a first-class motor, built for twenty-five cycles, the operation may be above question, the machine may be considered perfect in its way, but operating the same machine on fifteen cycles makes it possible to raise the induction from twenty-five to forty per cent, which means that much higher voltage may be applied at the same speed, thus giving twenty-five to forty per cent bigger output from the same motor. That in itself is a controlling item in the question. This result has been verified by actual test. Mr. Lamme pointed out the fact that the single-phase series motor can operate on both frequencies, fifteen and twenty-five. The tractive effort does not seem to be influenced by the frequency, particularly if they be spring suspended. Nearly all the European companies have adopted fifteen cycles.

Bion J. Arnold, after some brief reminiscences said he did not agree entirely with the paper that we should standardize at once. He is willing to concede, if we are going to use alternating-current railway systems, that probably we should adopt a standard frequency, and so far as his own investigation has gone, he leans toward the fifteen cycles, but he does not want to stand on that now. Although fifteen cycles gives a weight of the locomotive practically the same as twenty-five, as it increases the size of the transformer but reduces the size of the motor, it gets additional power on the locomotive and that is what we must get. We do not get as much power on the wheels with the alternating current as with the direct current. He believes that some form of high-potential overhead conductor is going to be the final solution of the railway question.

W. B. Potter endorsed the recommendation of the authors of the paper for a more perfect standardization of the systems and apparatus for railway work. However, standards are ordinarily secured where it does not cost anything to bring them about. One can hardly expect that a road, contemplating an equipment which would cost, say, $2,000,000, for the sake of standardization and in anticipation, perhaps, of sometimes effecting a junction with some other road at some distance, would spend $3,000,000, yet that is just what the selection of standards now would mean. There is no question but that the motor, limited as it is by the space between the wheels, the car body on the clearance over the track, is the device to which all of the rest of the equipment must be subordinated in order to get the best results. A great deal would be involved in the substitution of fifteen cycles for twenty-five. It would mean a considerable increase in cost for the generating apparatus; it is a frequency that is not suitable for lighting the cars, even, and a frequency which for every other use than the single-phase motor itself, and incidentally the conductor system from the generating station to the motor, would possess no advantage. He does not think, however, that we can look for the ultimate development of the single-phase motor on twenty-five cycles. We can build a motor that has good commutation, but it has a relatively small output for its size, weighing something like twenty-five per cent more than the direct-current motor having a corresponding capacity. With fifteen cycles, with the same degree of commutation, the motor would probably weigh from ten to fifteen per cent more only. Tests have shown that, assuming the tractive effort of a motor on direct current to be 100 per cent, on twenty-five cycles it varies from eighty to ninety per cent, and on fifteen cycles from seventy to eighty per cent, according to the condition of the rail. With alternating currents the slipping takes place in a series of jerks so that after the wheel has once slipped, it may take hold of the rail and have a higher maximum pull than before it first slipped, by reason of having cleaned the rail off. The average draw-bar pull after slipping with alternating current is perhaps seventy per cent greater than it is with direct current. Furthermore, except for freight work, where the motor is geared so as to have a high torque per ampere, there is little probability that an alternating-current, single-phase locomotive can be built sufficiently light so that any one need have no fear as to a lack of adhesion on the rails.

Referring to the high-voltage, direct-current system, Mr. Potter said that, by the addition of the commutating pole to

the ordinary direct-current motor, a motor designed for 600 volts can be run at 1,000 or 1,200 volts without showing any sign of arcing over or sparking. A 1,200-volt motor would have the same margin, so that so far as commutation is concerned, there has been an improvement made in the direct-current motor that is comparable to the advance made when the carbon brush was substituted in place of the copper brush.

W. S. Murray said that accurate records showed, on a freight basis, the steam locomotive shop repairs average 6.68 cents per locomotive-mile. On a passenger basis, the total cost per locomotive-mile is 5.6 cents as compared with eight and ten cents for the freight. Subdividing the passenger locomotives again into shop repairs and maintenance, the first, shop repairs, is 3.88 and maintenance 1.72. Mr. Potter had told him that 1.25 cents was the corresponding figure for the General Electric locomotive, No. 6,000, operating 50,000 miles on the test track, under severe conditions. Mr. Murray does not think it necessary to adopt a standard frequency yet.

O. S. Lyford described the equipment of the electrical section of the Erie Railroad, over which, on January 22, the first electric train ran into Rochester. This consisted of a motor-car equipped with single-phase motors and multiple-unit control for operation from an 11,000-volt trolley wire twenty-five cycles.

C. L. du Muralt exhibited diagrams showing the performance of various locomotives, which, he believes, show plainly the superiority of the electric locomotive over the steam locomotive, and more particularly of the three-phase, alternating-current locomotive, over anything else extant. A feature of the electric locomotive is its ability to carry overloads. A characteristic of the three-phase locomotive is its nearly constant speed at all loads.

A. H. Armstrong said that we have outgrown the days of a piece of apparatus having an indicated horse-power capacity under 2,000, and having a maintenance charge of eight or ten cents per locomotive-mile under the best level track operation, and double that when the conditions are adverse. We now have a piece of apparatus that under an endurance test of 50,000 miles has had a maintenance charge of less than 1.5 cents, a concentrated horse-power of 22,000, and capable of giving fifty per cent increase for unlimited periods with forced ventilation. With the asset we have in the electric locomotive we have reached the day when we can approach big problems in railroading with supreme confidence of winning out over the steam locomotive. It is not a case of types of apparatus, or a question of frequency. Each case has to be considered by itself. In ten years from now we will still be disputing over the question of frequency, alternating-current or direct-current operation. Looking back on the history of the steam locomotive, we have no standard.

N. W. Storer said the whole question of the electrification of steam railroads comes down to one of dollars and cents, and a system which can be operated and installed for the least money is going to be the one which is going to win out. His experience is that it generally comes down to the question of a locomotive of the single-phase type. The question of frequency is most important. Every time the single-phase locomotive comes up for heavy work, it very quickly brings up the question of frequency, and it nearly always, works down to fifteen cycles. Thirty per cent greater output may be got from motors with fifteen cycles than with twenty-five cycles. The fifteen-cycle motor approximates very closely the efficiency reached by the direct-current motor, and in power-factor, also, it comes very close to the direct-current motor. Above ninety per cent throughout the entire range is obtained in most sizes. The difference in cost of the locomotives, which is shown in the paper, is inadequate to cover what in his opinion would be the difference. It would be at least $5,000, which would be overwhelming in favor of the fifteen cycles. That figure will include transformer and everything on the locomotive. He believes that satisfactory lighting may be obtained with fifteen cycles by going to the low voltage lamp having a heavy filament.

William McClellan believes firmly the solution of the railroad problem is going to be by means of the high-voltage, overhead trolley, and the alternating-current, single-phase motor. He feels sure that nothing stands in the way of the standardization of fifteen cycles. Railroads to-day do very little exchanging of locomotives, but it will be impossible to electrify the railroads of this country if the cars are not exchangeable. He does not think great reliance should be placed on the rendered figures of cost of railroad operation.

W. I. Slichter thinks that the lower frequency (fifteen cycles) is very desirable for the single-phase motor. The output of the motor may be increased some thirty to thirty-five per cent by a decrease in frequency to fifteen cycles. He gave figures showing that on an interurban road using twenty-five cycles, the cost of the power-house is 34.5 per cent of the total, substations two per cent, low-tension construction 14.8, and low-tension copper twelve, high-tension 5.4, bonding seven, and equipments twenty-five per cent. Turning to fifteen cycles the power-house cost was increased to thirty-eight, substations to 2.1, low-tension construction remaining the same at 14.8, and due to the lesser losses in the track, the copper could be decreased to obtain the same losses, to eleven per cent; the high-tension construction remained at the same, 5.4, bonding the same at seven, and the total cost of equipments twenty-three, and making the total one per cent greater for the fifteen cycles. But comparing equipments for a road which approximates steam railroad practice, in which the cost of the equipments is increased approximately 100 per cent, with the cost of the power station in proportional increase, the figures come out quite otherwise, and very closely as given in the paper, which shows that as we go toward the heavy railroad work there will be more demand for the lower frequency.

Dr. J. B. Whitehead, Jr., said that vehicle is best which possesses two characteristics to the greatest degree. It should be self-contained and have the greatest power that can be got into it. The greater the distance between substations and the less complicated the apparatus the better. From the standpoint of self-containment we must look for something from the direct-current side before we yield the position taken by the advocates of the alternating-current system. He asked if there is any instance on record where there have been unpleasant results attendant upon a broken bond.

Mr. Stillwell, replying to Dr. Whitehead, said he did not know of any case in which danger has occurred from that cause. He believes that the discussion had settled the question of frequency in favor of fifteen cycles. The estimates given in the paper for rolling stock were, for twenty-five cycles, $150,000,000. Mr. Storer had said that the difference in favor of the fifteen cycles would be at least $5,000 per locomotive instead of $1,000. Scaling that down to $4,000, and applying that to 24,000 locomotives, the difference is $96,000,000, which is ten times the difference in cost of power-house equipment. He believes we are able to standardize frequency and the different positions of the overhead trolley, and this should be done.

The meeting was then adjourned.

The Mackay Companies' Interests in Telephone Securities.

In the listing of the stock of the Mackay companies on the New York Stock Exchange recently some interesting information concerning its holdings in the American Telephone and Telegraph Company was brought to light. In addition to its holdings in the American Telephone and Telegraph Company the Mackay Companies has stock holdings in a large number of important subsidiary Bell companies. The statement filed with the Stock Exchange is the first public compilation of the companies in which the Mackay Companies is interested. The amount of holdings in the various companies is not given, but it is shown that, including the entire capital stock of the Commercial Cable Company and various Postal Telegraph Companies, the holding company has stock in 102 cable, telephone and telegraph companies.

Of the Bell subsidiaries the Mackay Companies has stock in the Buffalo, Canada, Missouri and Philadelphia Bell companies, the Cumberland Telephone and Telegraph, the Hudson River, Michigan State, Missouri & Kansas, Nebraska, New England Telephone and Telegraph, New York & New Jersey, Pacific States, Pennsylvania, Pioneer Telephone and Telegraph, Rocky Mountain Bell, Southern New England, Tri-State Telephone and Telegraph and Western Telephone and Telegraph.

Of the cable and foreign telegraph companies in the list these are the more notable: Commercial Pacific, Commercial of Cuba, Direct West Indies, Direct United States, Great Northern of Copenhagen, Halifax & Bermuda, Deutsch Atlantische Telegraphen Gesellschaft, Mexican Telegraph, Montreal Telegraph and Western Telegraph Company of London.

The company has holdings, among others, in the American District Telegraph companies of New Jersey and Philadelphia and the Boston District Messenger Company. There is also a long list of subsidiaries of the Postal Telegraph and Cable companies.

Opportunity for Electric Lighting Plant at Havana, Cuba.

L. M. Harvey, of the Electric Contracting Company, Havana, Cuba, writing from Havana, states that there is a crying need in Havana for another plant to furnish light and power for the public. It is stated that a concession can easily be secured, and that there is considerable business ready to be signed up as soon as a new company enters the field.

Exposition of Safety Devices.

The inaugural banquet of the Exposition of Safety Devices and Industrial Hygiene was held on the evening of Monday, January 28, at the Waldorf-Astoria, New York city, under the auspices of the American Institute of Social Service. Charles E. Hughes, governor of the state of New York, was the guest of honor and chief speaker.

The grand ballroom of the Waldorf was crowded and the three galleries were filled with women. Among the diners were manufacturers, merchants, publicists, doctors, editors and other professional men. Josiah Strong, president of the American Institute of Social Service, presided. He, together with William H. Tolman, are the moving spirits in the undertaking.

At the speakers' table, besides Governor Hughes, were Colonel Carroll D. Wright, who was present as the special representative of President Roosevelt; Baron des Planches, the Italian Ambassador and dean of the diplomatic corps at Washington; Second Secretary Von Radowitz, of the German Embassy at Washington; Charles Stewart Smith, ex-Mayor Seth Low, Count Massiglia, consul-general of Italy; C. A. Coffin, president of the General Electric Company; Charles R. Flint, Dr. Thomas Darlington, President A. C. Humphreys, of Stevens Institute, and I. N. Seligman. Among those present, and who have taken an active interest in this work, were Arthur Williams, New York Edison Company; Emerson McMillin, and C. M. Heminway, Consolidated Engine-Stop Company.

The exposition was opened at the American Museum of Natural History on January 29, and will run until February 12.

This exposition is the first public demonstration of a national movement which has for its object the promoting of the invention and utilization of devices which will lessen the dangers to which American workmen are exposed in operating modern machinery.

During the addresses the speakers referred to the prevalence of preventable accidents which annually claimed a very great number of victims in the army of workers in this country. Reference was also made to the great numbers of victims of railroad accidents, the point being made by Dr. Josiah Strong, president of the American Institute of Social Service, that the danger of travel by rail is increasing more rapidly than the passenger traffic.

The exposition in the Museum of Natural History consists principally of operating safety devices gathered from all parts of this country and abroad. Admission is free and illustrated lectures are given by Dr. William H. Tolman, director of the institute.

The Sons of Jove.

A meeting of the Sons of Jove was held at the Electrical Club, New York, on Friday, January 25. About thirty new members were admitted, and the interesting ceremonies in connection with the initiation were carried through with an unusual degree of success. H. B. Kirkland was master of ceremonies, and Wm. Robertson, of Buffalo, presided during the Jovian meeting; assisting were, Van Rensselaer Lansingh, V. C. Gilpin, Harry Waterman and Philip Hoover. After the Jovian session a unique dinner was served in the basement of the Electrical Club. One hundred gentlemen were present. Instead of the usual formal dinner service, individual tables and seats were furnished in the way of wine boxes, one of which held the cover and the other was used for a chair. The room had been decorated for the occasion, and the informality of the affair was the cause of much merriment. J. P. Hall, president of the Electrical Club, presided at the dinner, although the responses were entirely impromptu. Brief speeches were made by George Weiderman, C. C. Sibley, H. B. Kirkland, M. R. Cockey, Charles A. Eidletz and Major Robert Edwards. During the latter part of the evening a vaudeville entertainment was given in the assembly room of the Electrical Club.

On the evening of Friday, January 25, a rejuvenation of the Sons of Jove was held at Chicago, Ill., at which fifty new members were initiated. A plan is on foot to form a Jovian lunch-room club, and arrangements are being made at one of the popular restaurants so that members of the order can gather together at special tables each day for lunch. Paraphernalia has been purchased for the exclusive use of the Chicago branch, and arrangements are being made so that more frequent rejuvenations may be held at Chicago.

Pays $3,000,000 Back Taxes.

The special franchise taxes of the Manhattan Railway Company for the years 1900 to 1905, inclusive, have been paid to the controller of the city of New York. The Interborough Rapid Transit Company, now the owner of the Manhattan elevated railroad system, forwarded four checks to the controller aggregating $3,170,141.70.

REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

Measurements of Inductance and Impedance.

In a discussion of methods of measuring the inductance and impedance of telegraph and telephone circuits J. E. Young considers the effects of impedance caused by iron in the circuit. In using a bridge system of balancing inductance or a zero method, if one of the inductances contains iron it will be found impossible to obtain a true balance, unless both inductances contain similar iron cores. The magnetic circuits of the two must be symmetrical. This is due to the fact that even though the total value of the inductance and of the time constants may be the same, yet they are not so from instant to instant; owing to the different magnetization of the cores. In testing with the key and a dead-beat galvanometer the inequality that exists will manifest itself as a double kick—that is to say, that getting the resistance balance, and approaching the inductance balance, it will be found that on making or breaking the key there is a kick first in a direction indicating less inductance is required in the balance arm, and then in the opposite direction. Hence for the calibration of the iron inductance, in the absence of a similar standard recourse must be had to absolute measurements. When the inductance under test contains iron, the most important factor which complicates the measurement is the variation of the permeability of the iron with the current strength acting on it. This quality might be called the specific electromagnetic capacity. Since inductance varies as the product of permeability and magnetizing force, which has a constantly increasing quantity, there is an increasing value of inductance as the strength of the current is increased. Hence the test current should be regulated roughly to the working strength which usually traverses the apparatus whose value is being measured. Another of the variations to be considered is that due to eddy currents in the iron. When making a test by rapidly interrupted alternating currents and a telephone this eddy effect becomes marked and the effective inductance decreases seriously. At the same time a variation is introduced by the eddy currents in the effective resistance of the inductance circuit under observation when measured by alternating or intermittent currents, due to the fact that these currents dissipate energy and thus increase the effective resistance. Besides the foregoing causes the value of the inductance depends also upon the previous history of the iron—that is to say, if the iron inductance under test has previously been magnetized by a strong current it will be found that the inductance comes out smaller than it did before the strong magnetization had occurred, owing to the residual magnetization. Accordingly, before making a measurement of the normal inductance of a piece of apparatus it should be demagnetized so as to remove the magnetization due to previous history.—*Abstracted from the Electrician (London), January* 4.

The Future Telegraph System.

A greater part of the telegraph systems of the world are conducted substantially according to the methods introduced by Morse. The Morse code is still in use and the Morse key and sounder, with practically little change. However, W. J. White believes that signs are not wanting that a critical period in the history of telegraphy has been reached. The requirements of commercial life to-day are such that the older system is barely able to cope with them. Progress obviously will lie in two directions: the maximum output of a system must be secured, and the cost of operation must be reduced. These two developments are, to a certain extent, antagonistic, so that to secure one advantage the other must be sacrificed somewhat. A brief review is given of various attempts to increase the capacity of a telegraph system, but none of the machine systems is thought to be entirely satisfactory. There is one feature in common with several of these systems: they require some kind of synchronizing device for their operation. Synchronism is at all times difficult to secure, and this difficulty is thought to spell failure to many projected type-printing systems. The ideal type-printing telegraph should be free from any synchronizing device. The great feature of the Morse system is its reliability. It will work not only under favorable conditions, but when conditions are most unfavorable. When quadruplex working is not possible, duplex can then be worked; and when this fails, simplex. If simplex can not be worked there is no telegraph system that can. With machine telegraphy the case is different. The slightest thing wrong with the synchronizing arrangements is sufficient to throw the whole system out of order, and it is necessary to have a Morse signaling set to control the working of the apparatus, so that the advantage often claimed for machine telegraphy—that it dispenses with the need of specially trained operators—is nullified. A second factor in the universal adoption of machine telegraphy is that of cost. The machine telegraph of the future will overcome, as far as possible, these disadvantages. It must be simple. The ideal is a typewriter keyboard operated by any one who can use a typewriter. An instrument at the other end should record the message in Roman characters, preferably in page form. What is wanted is a simple system in which the operator writes out at one end of a cheap line, and the message comes out written in page form at the receiving station. For lines which are more costly the line must be capable of being duplexed or quadruplexed. In any case the total message cost must be such as to enable the system to compete with all others, whether telegraphic or telephonic. Minor developments will probably come into being in connection with commercial work. Big business houses will have their private telegraph lines to the nearest office, a typewriter telegraph instrument being placed on the desk. An operator will write messages previously dictated. These will be received on a printing machine at the main office. An indicator will warn the operator there that the message is waiting. It will be taken from the receiver and despatched to its destination without delay. In a few moments the merchant for whom it is intended will receive a signal on the instrument in his office and, going to it, will get the message. —*Abstracted from the Electrical Review (London), January* 4.

Steam at High Pressures and Temperatures.

Some important research work has been conducted by Dr. DeLaval on the use of

high-pressure steam for steam-turbine propulsion. He has used steam pressures up to 1,500 and 1,700 pounds per square inch in his experimental work. Obviously, the use of very high pressures is impossible with cylinders of large diameter, so that this fact will always restrict the use of such high pressures in reciprocating engines and reaction engines, for the full pressure of the steam must be taken by the casing at the point of admission. This difficulty does not arise with impulse turbines, such as were used by DeLaval. It is pointed out that the usual tables giving the latent heat pressure, temperature and volume of steam are unreliable for pressures exceeding 350 pounds per square inch with a corresponding temperature of 432 degrees Fahrenheit. Some tables give figures going up to 550 degrees Fahrenheit, but all the values above 432 degrees have been extrapolated. This has been done upon the assumption that the empirical formula found to hold between thirty-two and 432 holds for higher temperatures; but the assumption is dangerous and may involve large errors. Experiments have been conducted by Cailletet, which have been confirmed by others, and which show that at about 689 degrees Fahrenheit, or perhaps a few degrees higher, the latent heat of steam becomes zero; whereas the empirical formulæ in question still make it a substantial amount at this temperature. The volume of the steam deduced from these equations is also wrong. Plotting the results of Regnault's work, the critical temperature of water is found to be 698 degrees. At this point, since there is no change of state, the latent heat is zero. This theoretical deduction has been confirmed in the case of carbonic acid gas. Plotting the results of Regnault's investigation, it is easy to calculate the number of heat units which would be turned into work by an ideal engine at any temperature. The most remarkable feature of these curves is found in the fact that there is a maximum efficiency at a temperature of about 640 degrees Fahrenheit. The result is apparently paradoxical, as generally the thermodynamic efficiency is greater the higher the maximum temperature. The reason, however, appears to lie in the rapid decrease of the latent heat as the critical temperature is approached; hence in an ideal engine steam at 1,400 pounds pressure would prove more economical than steam at 2,700 pounds. The figures show that a very considerable economy is thermodynamically possible by using steam at pressures of 1,000 pounds and over. However, large allowance must be made for losses due to mechanical and structural imperfections. At the present time the steam turbine seems to offer the most favorable solution of the problem, as there are no questions of initial condensation, which so largely reduce the commercial efficiency of ordinary reciprocating engines; nor are there glands to be kept tight under extreme pressures and temperatures, while the practice of velocity compounding makes it possible to keep down the bucket speed to a reasonable limit. — *Abstracted from Engineering (London), January* 4.

General Principles Appertaining to the Supply of Electricity for Industrial Purposes.

H. F. Parshall discusses here the general principles appertaining to the supply of electricity. One advantage of buying power is the freedom of each individual to carry out his own business unhampered. Moreover, the power plant takes up a certain amount of valuable space in his factory, and there is less risk of failure when power is drawn from a large supply system. In spite of these two advantages, the power must be supplied to the factory at a less rate than that at which it can be generated there. Assume that a number of individuals associate together for the purpose of providing a common source of electricity for use in their works, and each shareholder's investment is in proportion to the power which he requires. No individual would participate in such an enterprise except in the belief that his share of the capital investment would be less than the expenditure required to provide a power plant on his own premises, and that his share of the expenses of the common supply would not exceed the expenses of generating his own supply. Electrical power supply is not undertaken in this way. It is promoted by manufacturers and others who have found that the business is a profitable one. In order to secure rapid growth the terms must be somewhat more liberal than is necessary to supply well-established industries. The economies which follow from a concentration in one large plant result from the use of large generating units and a more uniform and steady load. Capital is economized by saving in the capital cost of a few large units as compared with the cost of a large number of small units; a saving in the cost of land and of housing (the building may be placed in a locality where land is cheap and where a cheaper class of building is permissible); and by the fact that the amount of apparatus to be provided by the power supply undertaking is much less than the aggregate of the individual users of the plant. Cheap production results from the superior efficiency of large units, a steady and more uniform load, an expert knowledge applied to production, cheaper coal due to accessibility of the power station and the conveyance of coal in large quantities. Generally the greater the distance from the coal field the greater the advantage in favor of the power supply company. The largest practical unit for a prime mover of the reciprocating type is 5,000 kilowatts. Beyond this, mechanical unwieldiness interferes with operating economies. The advantages are thought to be in favor of the steam engine as compared with the gas engine, while the steam turbine makes possible the use of much larger units. Steam turbine units have been constructed which are rated at 12,000 and even 20,000 kilowatts, but it is doubtful whether such very large units offer any great advantage, as the saving in capital cost is a small proportion of the total cost, and the gain in efficiency is small. Nor in such cases is there much gain in floor space, as this is mainly determined by the number of boilers and auxiliary apparatus. Assuming an undertaking having a rating of 120,000 kilowatts for continuous working, a suitable unit for power would be 12,000 kilowatts. Such a station could be equipped complete for $50 per kilowatt, a total of $6,000,000. The transmission system from the power-house to consumers could be erected for $80 per kilowatt. This would cover an area within a radius of ten miles. The total cost would therefore be $130 per kilowatt. Preliminary expenses of development, land, etc., would be about $150 per kilowatt. With this station containing ten 12,000-kilowatt units, two should be set aside as reserve, leaving eight generators with an aggregate output of 96,000 kilowatts. Since, however, the load would not come on the station at the same time, it is probable that a favorable distribution could be secured giving a diversity factor of one and one-half—that is to say, the station could have a commercial rating of 144,000 kilowatts; so that the total capital cost would be $125 per kilowatt. The fixed charges to the consumer would therefore be $10 per kilowatt-year. With coal at $2.50 per ton the operating cost would be 0.4 cent per kilowatt-hour, so that the total annual charge to the consumer should be $15 per kilowatt-year, plus 0.4 cent per kilowatt-hour for the energy used. On this basis a factory employing from 100 to 300 horse-power, operating fifty-four hours a week, would be charged $20 per horse-power-year. To generate its own power costs at the present time $25. The figures are thought to show that this undertaking would be profitable, if the principles outlined above are observed.—*Abstracted from the Electrical Engineer (London), January* 3.

Methods of Getting New Business

A DEPARTMENT DEVOTED to the COMMERCIAL DEVELOPMENT of CENTRAL STATIONS

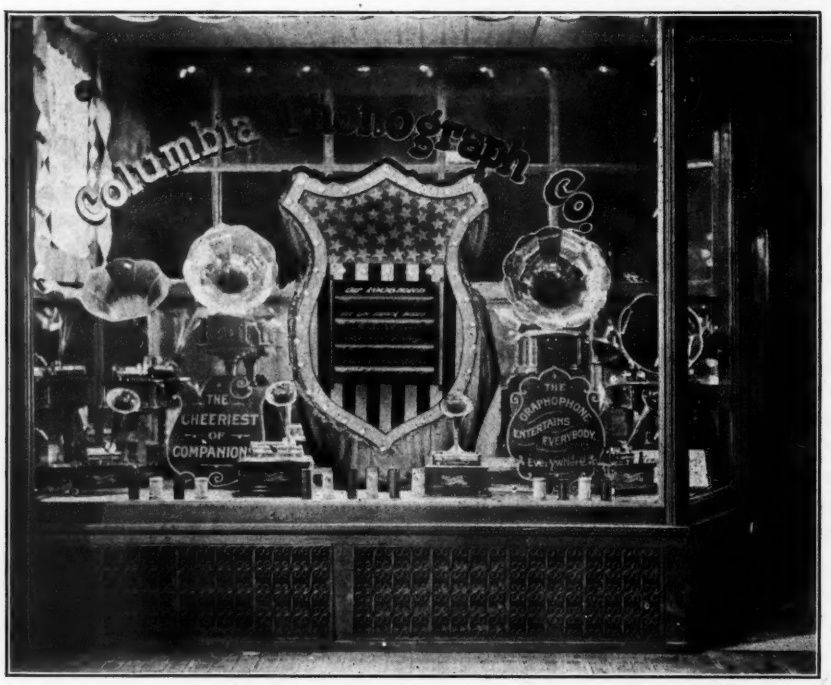
Managers are Invited to Contribute Suggestions for Methods of Increasing the Demand for Electric Service

EDITED BY CHARLES A. PARKER.

Central Station Systematizing.

Probably you know among your acquaintances a shining example systematizer—one who can press one of the numerous buttons on his desk, first consulting a card index to find which is which and summon Miss Jones.

Miss Jones, with the aid of several assistants and a carefully kept index, in a comparatively short space of time will be able to place in the hands of Mr. Shining Example a card with the complete record of Bill Brown, over on Butternut street.



The use of electric light in store windows to decorate a particular display such as is here shown is on the increase. Mr. Solicitor, bring this to the attention of some "live one" in your city.

Bill wrote exactly two years, five months, three weeks, three days, two hours and twenty-five minutes ago—as is very plainly recorded on the card.

His card shows that he has had all the advertising literature that has been sent out during this interval.

He has also been favored with the usual follow-up letters sent to enquirers—all of which is properly entered on the card.

If Bill had written this letter to a non-systematist, he would have been favored with the same dose, but perhaps the non-systematist wouldn't have made such a fuss over Bill and bothered to enter on his card what every one knows has happened.

In addition to carefully recording every move Bill or Mr. Shining Example has made since Bill first said "play ball," there has been properly entered a complete record of all the filthy lucre Bill has got rid of—this saves looking at Bill's ledger account, in case Mr. Shining Example should ever have time to hear of Bill.

Bill has also been favored with many calls by the solicitor who regularly "makes" Bill's territory (and sits up nights making reports of every move the previous day).

Besides the many other interesting things we learn about Bill by studying his card, we find that Bill is a pretty successful merchant and has favored our friend, Mr. Shining Example, with a contract for an electric sign, and, Bill not being "wise" to the fact how much bother and expense he has been causing Mr. Shining Example, has all this time been splitting up his trade with the gas company, which perhaps is a little weak in its "system," but just as strong in some other respects; therefore Bill was as willing to buy of one as the other.

So much has been written in praise of system that there is considerable danger of its importance being over-valued.

While it is undoubtedly true that a good, broad common-sense system is absolutely essential in properly conducting a central station, it is equally true that a lax system is just about as desirable as one of these complex, brain-racking Chinese puzzle systems that keep three or four men busy "keeping tab" on one man who really does all the necessary work.

A system should always be subordinate—not dominant.

It should be flexible, not hidebound.

The old proverb reminds us that we eat to live—we do not live to eat.

So, too, we should organize and maintain system in our business purely for the more profitable conduct of that business, and not, as some enthusiasts apparently do, run their business to maintain a certain system which they've got "stuck on" and "with."

A pretty safe rule to follow is—the minute the system begins to interfere with the business, study out a new one that is adequate. If the system is not helping matters, it has no excuse for existence, for it ceases to be useful and is a handicap.

There are a great many large central station enterprises which can afford and have a right to maintain a big force—an extensive force—to carry on the business according to set rules.

In such cases an elaborate system is very right and proper, and may be properly employed.

The trouble arises when a small central station adopts this big system and endeavors to make it fit its small business.

There are just as many parts and duties for the crew of a small yacht as for that of a big cruiser, but what sense would there be in trying to carry the same crew as is necessary to operate the larger vessel?

It would not only be absurd, but impossible.

System, like fire, is a good servant but a bad master.

It is a good business to study the system and methods employed by the large con-

cern, but it is equally important as well not to be carried away with too much system.

Get the good out of the study—copy the spirit, not the letter.

The Chinese have a proverb that runs like this: "First the man takes a drink, then the drink takes a drink, then the drink takes the man."

And the same proverb might be truthfully altered to read: "First the man adopts the system, then the system adopts the system, then the system adopts the man."

There is no end, in other words, to the waste of money, of energy, of labor and of trouble once too much system begins to handicap a business instead of the business using the system.

out "all by yourself" or call to your aid an experienced systematizer.

That's all.

Use common-sense. Don't be led away by thinking that system is some miraculous mercurial thing that will in some subtle way draw all things unto it.

In these days of elaborate systems, elaborate labor-saving devices, new-fangled accounting, etc., etc., it is indeed a cool central station man who can always keep a steady head and select the winners to adopt to advantage in his business. It is very largely a matter of business judgment.

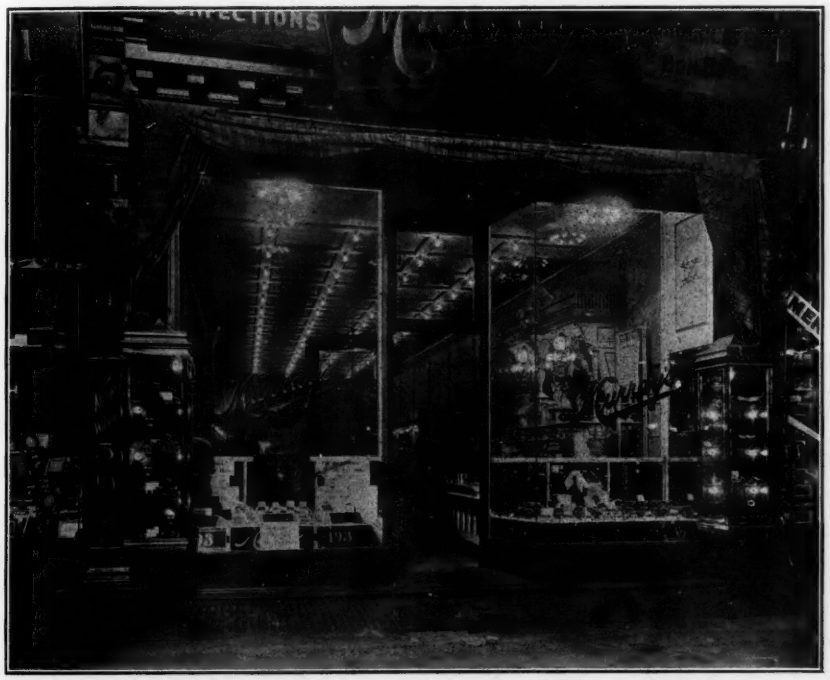
Have a system.

Make a study of it.

Stick to it.

But don't let it run you.

As soon as you outgrow it, improve upon



An example of ceiling lighting that should prove inspirational to new-business getters.

But system has its place.

No business, no matter how small, can run without it.

To ignore system is to neglect your business. Because, after all, system is business and business is system.

They're not two things, but one.

You ought to have just as much system as will help your business—not an ounce more.

Rules for installing a system for your business?

There aren't any!

It's up to you.

What proves very satisfactory for one may be a handicap for another. Your own good brains and common-sense will aid you in arranging a system that will fit your business, whether or not you study it

it—get a bigger one, a broader one, one that will fit the changed conditions.

Under this heading we shall, from week to week, present to our readers a little series of inspirational aphorisms (original, aboriginal and selected), which will, we believe, prove stimulating and suggestive to those who are interested directly or indirectly in the sale of central station current.

The best you can do for a customer must be determined by an estimate of the best you can do for your employer.

Finding good business is in reality finding good friends who will do business with you and profit thereby.

Don't talk John Henry twaddle—talk persuasion.

To make money you must satisfy your customers.

Our enemies will not deal with us. Be the one that makes the most friends.

Get down to cold facts and dish them up on a warm plate.

Take the other fellow's point of view—then convince yourself.

Continual urging is the price of success to all central stations.

No man is so dense, so stupid as one who, while unsuccessful, persists in holding to the beliefs that make him so and refuses to try other methods because he does not believe in them.

Under this general heading we shall present to our readers a series of bright, stimulating talks to solicitors, which, we believe, will prove valuable to managers of new-business departments in suggesting points which they can profitably bring out in their occasional meetings with the company's representatives.

We shall gratefully accept contributions and suggestions from any of our readers.

We have a deep-rooted conviction here at the office that either some of you fellows aren't carrying the right ammunition to bring down your game, or else your nerves aren't steady enough to shoot straight.

Your reports this week show "prospect will close later" to dominate your movements.

Now, you know the old story of "waiting."

You know how many prospects deep in their hearts mean to buy later.

And you are just the fellow to make them buy now; to inject into their systems the telling shots that will hit the mark.

And your enthusiasm, your knowledge and belief in your product should be imparted to them.

When you enter a business office be loaded up with answers to objections.

Don't let your prospect get in one telling shot.

Have a ready answer to shoot back at him, and aim it at a vital spot.

Catch the drift of his objections and gradually lead him up to what your product will do for him.

And when he's interested in you, then

put on steam and fill him full of a desire to buy.

Make him not only desire your goods, but make him feel he can't get along without them.

And don't give him a chance to say: "A little later," because you have as good a grip on him now as you ever will have. And make it count now.

Clinching an order and closing a sale are the tests of salesmanship.

Because, we might interest a prospect by mail. Might even lead him up to writing "probably will close contract later."

But what you are for, Mr. Salesman, is to clinch the business now.

And no amount of dangling your hook will get you anything unless you land your fish.

Study yourself, study electricity, study your territory.

Pack yourself so full of talking points and answers to arguments that the hardest-headed, closest-shelled old boy will warm to your way of thinking. And don't let him edge away or put you off.

And make him feel he's doing himself, not you, a favor by signing.

Take a good drink from the ginger jar this trip.

And let us have more actual contracts and less prospective ones.

It will be our endeavor, from week to week, to present in this department brief notices of activities among the central stations, as gathered from men who are in the field and, consequently, in close touch with the progress of the new-business idea and its acceptance by central-station managers. Contributions to this department are solicited, and will be received with much appreciation by the editor.

If you are doing something a little better than or different from the other fellows, and think it would make interesting reading to ELECTRICAL REVIEW readers, send in your schemes and plans. They will be gladly received.

Address all communications to Charles A. Parker, care of the ELECTRICAL REVIEW.

A clever combination advertisement, in which the 1900 Washer Company and the Union Electric Company, of Dubuque, Iowa, recently figured, is the booklet of which we publish an illustration entitled "Doing a Big Week's Washing with the 1900 Self-Working Washer."

You will note that the illustration on the cover shows the washer belted to an electric motor.

The inside pages of the book are given to a strong and forceful talk about the washer, while the title page contains a strong talk on doing washing by electricity and extends a cordial invitation to readers of the book to visit the exhibition department of the Union Electric Company, Du-

Cover of booklet describing electrically driven washer.

buque, Iowa, and there to see a practical demonstration of washing and wringing clothes by electricity.

The Danville Street Railway and Light Company, of Danville, Ill., is among the aggressive army of central stations which have decided on the wisest course of acquainting the people of the advantages of electricity and the profits to be enjoyed from its use.

The past few months have marked the issuance to the merchants of Danville of a very effective and excellent campaign of direct-by-mail advertising on the subject of electric signs and electric light for display purposes generally.

Here is the text matter of one of the attractive mailing cards issued in this campaign:

ELECTRIC LIGHT INVITES TRADE.

Show your confidence in the goods you sell.

Light up your place of business and goods with electric light.

You are a "live one"—prove it to the people.

Here's how—an electric sign, electric window illumination, electrically lighted interior.

On the back of the card the points are further driven home by strong argumentative talk which, it seems to us, must succeed in overcoming any prejudice that might exist either as to the effectiveness of electrical advertising, or as to the undue expensiveness of electrical advertising.

The card is well printed in three colors, and shows a design of a figure with an electric light bulb constituting its head, extending the right hand of fellowship to an attractive damsel in a red coat with hat to match, who wears a pleased expression as much as to say she is not averse to the radiant smile with which Mr. Electricity beams upon her.

HANG ME UP
Electric
Light
Invites
TRADE
Show your confidence in the goods you sell. Light up your place of business and your goods with Electric Light.
You are a "live one"
Prove it to the people—Here's How:
An Electric Sign
Electric Window Illumination
Electric-Lighted Interior
(Electricity—cleanest, brightest, healthiest, safest, best.)
(OVER)

An attractive mailing card sent out by the Danville Street Railway and Light Company, Danville, Ill.

INDUSTRIAL SECTION

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS

Detroit Insulated Wire Company.

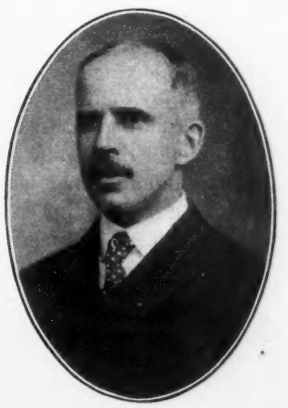
One of the vigorous new enterprises that has entered the electrical field under favorable conditions is the Detroit Insulated Wire Company. This company, with energy characteristic of its organizers, has this season built and equipped a thoroughly modern plant for the manufacture of rubber-covered wire. The active management of the company's business is in the hands of men long and favorably known in electrical circles.

J. H. Hunter, formerly of the National Cable and Wire Company, is vice-president, and is in charge of the manufacturing operations of the concern. Mr. Hunter is a native of Pittsburg, and his early technical training was acquired at

J. H. HUNTER, VICE-PRESIDENT, DETROIT INSULATED WIRE COMPANY.

the Western University of Pennsylvania. While there much of his attention was directed to electrochemical problems, particularly those bearing on the manipulation of organic substances. Mr. Hunter's first active connection with the electrical business was as electrical engineer for the Allegheny County Light Company, of Pittsburg, Pa., with which he was associated for seven years. Later he formed a partnership with Professor Koch, of the department of chemistry at the Western University of Pennsylvania, for the manufacture of certain chemical specialties. His interest in this firm still continues Mr. Hunter was instrumental in securing a franchise in Pittsburg and Allegheny for the Pittsburg & Allegheny Telephone Company. His connection with this company as engineer of ways covered the period of construction and equipment, during which time he had exceptionally good facilities for studying every detail connected with the design and maintenance of large telephone installations, and became particularly absorbed in the study of problems incident to the use and upkeep of their distributing systems. In due course of time Mr. Hunter purchased an interest in and was elected vice-president of the National Cable and Wire Company, which under his management manufactured rubber-covered and weatherproof wires and lead-covered cables with insulation of paper and other substances for electric lighting, power and telephone purposes.

Arthur Hartwell, formerly sales manager of the Westinghouse Electric and Manufacturing Company, is secretary and treasurer of the Detroit Insulated Wire Company, and in active charge of the general management of the enterprise. Mr. Hartwell is a graduate in mechanical engineering of the Ohio State University, of Columbus, Ohio. Soon after leaving college he entered the employ of the Westinghouse Electric and Manufacturing Company with which he was associated for upwards of fifteen years. While in the employ of this company Mr. Hartwell was at one time or another associated with every department of its manufacturing operations except the drawing room. In 1890 he had much to do with the design and installation of the first long-distance transmission plants put into commercial use in this country. These plants are the famous plants installed at Portland, Ore., and Telluride, Colo., in the early nineties. In 1895 he was appointed manager of the Pittsburg sales office of the Westinghouse company, and had charge of branch offices at Cleveland and Cincinnati, Ohio, and Buffalo, N. Y. In 1899 he was appointed to a similar position in charge of the Chicago office with branches at Minneapolis, Detroit and Omaha. Under his administration these branch offices, with the exception of Omaha, grew to the point that each was made independent of the parent office with a manager of its own. In 1901 he was promoted to be the head of the sales department with the title of sales manager. During his administration the sales organization was reorganized into the present divisions of the department: railway and light, detail and supply, and industrial and power; each division with a separate manager as an active assistant to the sales manager. In 1904 Mr. Hartwell acquired an interest in the Sterling Varnish Company, of Pittsburg, of which he became a director as well as general manager. He brought this company's business up to the point where new records in sales and net profits were made at which time he sold his interests and resigned with the intention of reentering more actively into the electrical field. As a salesman and sales manager he has al-



ARTHUR HARTWELL, SECRETARY-TREASURER, DETROIT INSULATED WIRE COMPANY.

ways held the theory that the jobbers of electrical supplies perform an important and indispensable function for the manufacturer. That as purchasers for resale they are entitled to a liberal margin of profit and protection.

The Detroit Insulated Wire Company's new factory is equipped with the most approved and carefully selected devices for the manufacture of rubber-covered wire that have been developed. Those departments of its factory in which insulation is applied to small sizes of conductors are completed and in operation. The other departments are being put in operation as rapidly as the present congested conditions among manufacturers will permit.

Rail Bonds.

As the importance of good track bonding becomes better understood, the requirements become more specific. No one type or form of rail bond will satisfactorily meet all track conditions. Recognizing these facts, the American Steel & Wire Company, pioneers in the manufacture of rail bonds, have within the past few years not only greatly improved their old standard types of bonds, but have developed entirely new types, and a very complete set of high grade tools for installing bonds.

Soldered Rail Bond, Form 1.

Soldered Rail Bond, Form 2.

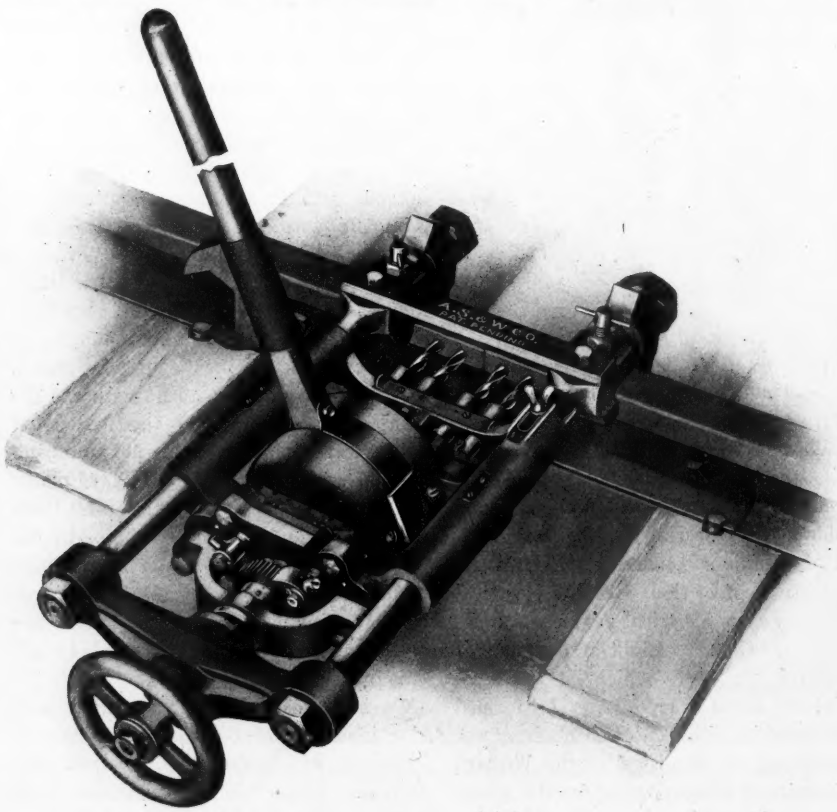
The "Crown" and the "United States" types of single terminal-stud bonds are well known to the trade and need only be mentioned here. They are made up in all forms and capacities and have either the solid compression or the tubular pin —expanded studs. This company also makes a very complete line of soldered bonds suitable for attaching to any section of the rails. These bonds have special features, such as great flexibility, large contact surfaces, and so on, which distinguish them from other forms.

Soldered Rail Bond, Form C.

Soldered Rail Bond, Form 4.

The "multi-terminal" type of bond, in which each terminal has two or more half-inch studs compressed in corresponding cup-shaped holes drilled in the head of the rail, not only possesses distinct advantages all its own, but it is lacking in none of the good properties of other types. This bond stands in a class by itself as the nearest approach yet made to an ideal bond. It is an exposed bond which is applied to the head of the rail without disturbing the joint, and at a very low cost. Owing to its special form, to the unique way of anchoring and sealing the contact, and to the very large contact area of each multi-stud terminal, this bond is very flexible, durable and efficient.

New Style Screw Compressor.

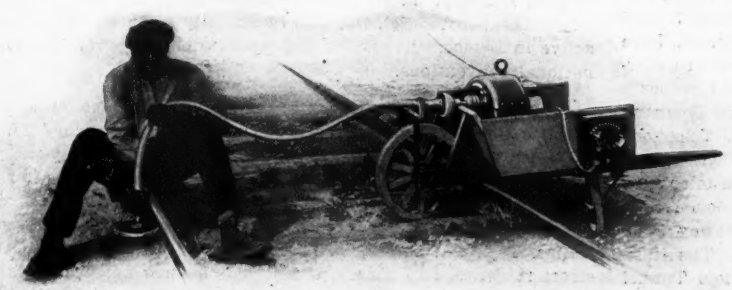


Four-Gang Rail-Drilling Machine.

The cost of drilling the rails for this type of bond is reduced to a minimum by using a multiple spindle drill which has

been developed for this purpose. Machines are made which will drill one, two, three or four holes in a single operation. These machines are unique and simple in their design and construction, and mark a step forward in the art of rail bonding. Each machine has a positive automatic feeding device, ball bearings, an independent adjustment of drills longitudinally, and an index marking the correct depth of holes. By means of strong clamping devices they are attached quickly and rigidly to the rails and in consequence the holes are drilled smooth and exactly to size, features of great importance in rail bonding. Each machine is operated by a detachable lever, each stroke of which drives the drills forward. The four-spindle drill may also be operated by a light but powerful 500-volt motor.

Portable Hydraulic Rail-Bond Compressor.



Portable Electric Motor and Grinder for Attaching Soldered Rail Bond.

The American Steel & Wire Company also make a complete set of hydraulic bonding tools having many distinctive features and a new and improved form of screw compressor. In the latter, the old form of outer screw has been replaced by a quick-acting and self-centering device by means of which it is possible for the operator to produce uniform and most efficient results.

This company has recently equipped a new and very extensive rail bond factory, and has engaged the services of experts who devote their entire attention to the construction of rail bonds and appliances.

Electric Motors for Sawmills.

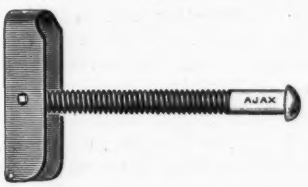
The Great Southern Lumber Company will install a complete electrical equipment in its new mills at Bogalusa, La. The company controls various properties in different lumber centres, and the new mill will be not only the largest in the United States, but also will have the most complete electrical equipment. As a result of this latest industrial centre a new town is being built within the confines of the old, which before had not even a post-office.

The electrical equipment will be furnished by the General Electric Company, individual induction motor drives being used on all of the machines, the total motor equipment aggregating some 2,400 horse-power.

At the new mill, the generating equipment will comprise three generating units, direct connected to steam engines. Two of these units have 500-kilowatt generators while the third unit will be of smaller capacity, generating about 300 electrical horse-power. All three units will be of the General Electric, three-phase, revolving-field type, running at 100 revolutions per minute and generating current at a potential of 2,300 volts, and a frequency of sixty cycles. The power-house will also contain two direct-connected marine generating sets, each consisting of a thirty-kilowatt generator, driven at 305 revolutions per minute by a vertical engine.

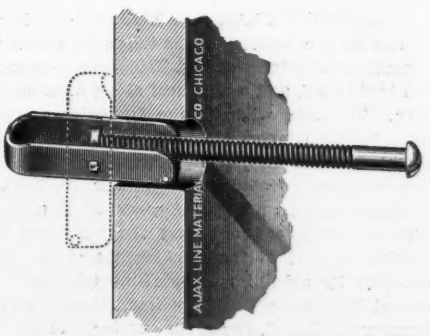
A New Toggle Bolt.

With the rapidly growing use of hollow tile for the partitions and ceilings of office and school buildings, there has come an increased demand for bolts to fasten conduits, fixtures, etc., to such tiling.



Ajax Toggle Bolt in Holding Position.

A new type of bolt for this use has been devised by Albert Scheible, which is shown in the accompanying illustration. The bolt is being marketed as the Ajax toggle bolt. The nut of the bolt is pivoted in a U-shaped headpiece, which has a bar across the open end to keep the head parallel to the bolt when it is being inserted, as shown in Fig. 1. Then a half-turn of the bolt drops the head across the opening, so that the bolt can quickly be tightened, leaving only the screw-head exposed, as the surplus of thread is hidden in the wall. The new bolt is made in eight sizes by the Ajax Line Material Company, of Chicago, Ill.



Method of Inserting Ajax Toggle Bolt.

Current Electrical News

DOMESTIC AND EXPORT.

GERMAN COMPANIES TO LIGHT BOSPHORUS TOWNS—Electric lighting of Pera, Galata, Bechiltash and other towns on the Bosphorus has been sanctioned by an irade of the Sultan of Turkey and intrusted to two German companies, the Allgemeine Electricitäts Werke and Siemens & Halske.

NORTHERN INDIANA RAILWAY—It is reported that the Dieterich syndicate, of New York, the Murdocks, of Lafayette, and Hugh McGowan, of Indiana, have paid $4,000,000 for the Northern Indiana Railway, and taken charge, and that they have also acquired the street-railway lines of Michigan City, South Bend and Elkhart. The Northern Indiana runs from Goshen through those cities. An extension will be built direct from South Bend to Chicago *via* Michigan City.

EXTENSION OF PENNSYLVANIA TROLLEY SYSTEMS—The York Trolley Company and the York County Traction Company, York, Pa., have made plans for an increase of their mileage from seventy-five miles of track to 200 miles. It is said that the new company will have an authorized bond issue of $2,000,000 for the purpose of constructing the new lines. One of the first to be completed will be the road from York to Hanover. All of the rights and franchises have been secured, with the exception of a way through West York borough.

NEW TELEPHONE COMPANY INCORPORATED—The Independent Telephone Company, of Omaha, Neb., with a capital stock of $5,000,000, has been incorporated by F. H. Stow, formerly of Los Angeles, Judge Benjamin S. Baker, of Omaha, and W. F. Ely, formerly of Portland. The promoters were granted a franchise to construct and operate a telephone system in Omaha at the last election. The capital stock of the company is divided in 35,000 shares of preferred stock and 15,000 shares of common stock at $100 a share. The preferred stock has no voting power. It is expected that a large bulk of the stock will be held by the Union Telephone Construction Company, which has contracted to build the Omaha system. The dividends are to be paid, first on preferred stock up to four per cent, then on common stock up to four per cent, then on preferred and common on an equal basis.

TELEPHONE PLAN ABANDONED—It is announced that negotiations for the transfer of the telephone rights of the Illinois Tunnel Company to the Independent Telephone Company, Chicago, Ill., have been broken off, and a new deal along different lines has been undertaken. The deal whereby the franchise and undeveloped property owned by the telephone department of the Illinois Tunnel Company in Chicago was to be transferred to the Independent Telephone Company was effected on November 30, 1906, in consideration of $10,000,000 and an additional rental of $5 a year for each telephone. Thus the announcement that the plan has been abandoned is a surprise to most of the stockholders of the Chicago Subway Company and its subsidiary, the Illinois Tunnel Company. The Independent Telephone Company has already paid the Illinois Tunnel Company $3,000,000, has agreed verbally to pay the remainder within the next five years and to install all the new instruments and equipment required.

LIGHT AND POWER COMPANY FORMED—Articles of incorporation have been filed at San Francisco, Cal., for the City Electric Company, which has been formed for general lighting and power purposes. The capital stock is $5,000,000, of which $9,000 has been subscribed. The directors are Adolph Mack, J. J. Mack, Henry Steinbach, Mortimer Fleishhacker, Herbert Fleishhacker, W. S. Goodfellow, Charles P. Eells, Frank W. Smith and Walter Arnstein. Mortimer Fleishhacker and other directors of the new company state that the concern has nothing to do with the San Francisco Coke and Gas Company merger, and that it will be entirely independent of any other organization. The machinery for the new plant has been ordered and the promoters say that work on the plant, the site for which will be at some location not yet chosen on the bay shore, will begin at once. It is the intention of the company to manufacture all its electricity in San Francisco by the use of oil fuel. Turbine engines, the first to be introduced in San Francisco, will be used for the generation of the electrical current. The company will manufacture electricity for general lighting purposes and its directors expect to reduce the present cost of that commodity. The plant will have a capacity of 10,000 horsepower.

NIAGARA POWER—Secretary Taft has decided that the diversion of 15,600 cubic feet of water a second from the American side and the transmission of 160,000 horse-power from the Canadian side of Niagara Falls will not affect perceptibly the scenic grandeur of the falls. Permits will accordingly be issued to the Niagara Falls Power Company for 8,600 feet and to the Niagara Falls Hydraulic Power and Manufacturing Company for 6,500 feet. In regard to the water taken from the Canadian side of the falls he points out that it is taken from a level much lower than the point above Goat Island where the river divides to make the American and the Canadian falls, and therefore its diversion can not affect the amount of water which passes over the American falls. He therefore directs the issuance of permits to these companies for the power brought across the boundary line: the International Railway Company, 1,500 horse-power; the Ontario Power Company, 60,000; the Canadian Niagara Falls Power Company, 52,000; the Electrical Development Company, 46,000. To remove the unsightliness of the buildings on the American side caused by the presence of power-houses and other evidences of commercialism and to restore the cañon to a condition which will be more in harmony with the beauty and grandeur of the falls, he appoints a committee composed of Charles F. McKim, Frank D. Millet and F. L. Olmsted to prepare a plan and advise him what changes are needed.

OBITUARY NOTES.

MR. GEORGE A. BOWDEN, proprietor of the Youngstown (Ohio) Gas and Electric Fixture Company, died at his home in that city on January 19.

MR. ROBERT L. ALLEN, manager of the Economy Light and Power Company, Joliet, Ill., died in that city recently. Mr. Allen was active in Democratic politics and represented his party in state and national conventions.

MR. S. E. WILLIAMS, manager of the Jacksonville (Fla.) Electric Company, died after a short illness, on January 14. Mr. Williams was born at Eastchester, N. Y., and was thirty-one years of age. He was a graduate of Harvard University, and after leaving college became connected with Stone & Webster, Boston, where he remained for about two years. He was then transferred to Dallas, Tex., where he became the assistant manager of the Dallas street railway. In January of last year he was appointed manager of the Jacksonville Electric Company. In addition to Mr. Williams' connection with the Stone & Webster syndicate, he was secretary of the Rapid Transit Street Railway Company, of Dallas, Tex.

ENGINEERING SOCIETY NOTE.

THE ENGINEERS' CLUB OF CENTRAL PENNSYLVANIA—The Engineers' Club of Central Pennsylvania, with headquarters at Harrisburg, Pa., announces in its annual report a total present membership of 270. There is a balance in the treasury of $232.44, after expending $2,213.89 for the work of the club. On January 8, at the annual meeting, the following officers were installed to serve during the ensuing year: president, Thomas Earle; first vice-president, L. K. Kinnard; second vice-president, J. K. Crowell; secretary and treasurer, I. S. Lewis; directors for three years, D. E. Tracey and W. B. McCaleb.

PERSONAL MENTION.

MR. FRED W. GODFREY has been appointed district manager of the Cincinnati (Ohio) office of the Bryan-Marsh Company, Chicago, Ill.

MR. CHARLES A. MUNROE, Chicago, Ill., has been elected general manager of the Economy Light and Power Company, of Joliet, Ill., to fill the vacancy caused by the death of Robert L. Allen.

MR. W. H. OWENS, superintendent of the Madison County Light Company, operated by the McKinley syndicate, with plants in Edwardsville and Granite City, Ill., has been transferred to Decatur, Ill. He was succeeded by E. D. Bell, of Granite City.

MR. WILLIAM SCHLAFGE has been appointed master car builder of the Erie Railroad, with headquarters at Meadville, Pa. In a personal note in the issue of the ELECTRICAL REVIEW for December 15, on page 997, this mention was made misleading because of an unfortunate printer's error.

MR. T. H. ABERNATHY, for several years manager of the gas and electrical departments of the Birmingham Railway, Light and Power Company, Birmingham, Ala., has resigned his position. He is succeeded by Mr. A. V. Pope, of the sales department. Mr. Abernathy will engage in business for himself.

MR. HENRY HOLLINGSHEAD GEARY was married to Miss Fannie Hazel Leppard, at the home of the bride's sister, Mrs. Andrew Emerline, Jr., Fostoria, Ohio, on the afternoon of January 23. The bride is the daughter of Mrs. Fannie E. Leppard. Mr. and Mrs. Geary will spend several weeks in the South, and upon their return will live in Fostoria. Mr. L. P. Sawyer acted as best man at the wedding.

MR. CHARLES D. WALCOTT, director of the United States Geological Survey, has been chosen to succeed the late Samuel Pierpont Langley as secretary of the Smithsonian Institution, Washington, D. C. Mr. Walcott was born at New York Mills, N. Y., March 31, 1850. He became an assistant in the New York state surveys in 1879. He was appointed assistant geologist in the geological survey in 1879, and took up the study of the Cambrian rocks, the oldest known upon the globe. In 1894 Mr. Walcott became the director of the United States Geological Survey, succeeding Major J. W. Powell.

MR. THEODORE P. SHONTS will retire on March 4 as chairman of the Isthmian Canal Commission and become president of the Interborough-Metropolitan Company, New York city. Mr. Shonts has handed his resignation from the government service to President Roosevelt, and has been elected president of the Interborough-Metropolitan. He enters the Interborough-Metropolitan service at the express request of August Belmont, whom he succeeds as president; and leaves the government service with the consent of President Roosevelt, Secretary Taft and other officials of the administration. President Roosevelt has highly commended the work of Mr. Shonts as chairman of the Isthmian Canal Commission. Mr. Shonts will be succeeded by John F. Stevens, the chief engineer of the canal proposition. August Belmont will remain as chairman of the boards of directors of the various companies in the rapid transit combine. John B. McDonald, the subway builder, has been elected vice-president and superintendent of construction of the Interborough-Metropolitan company. E. P. Bryan has been elected president of the Interborough Rapid Transit Company, which operates the subway and elevated lines on Manhattan Island and is one of the subsidiaries of the Interborough-Metropolitan company.

EDUCATIONAL NOTE.

LEHIGH UNIVERSITY—The Electrical Engineering Society, of Lehigh University, South Bethlehem, Pa., has prepared an unusually interesting programme for the monthly meetings during the college year. Several papers or addresses have been arranged for each meeting and the work of the year will take up all branches of electrical engineering. A number of special speakers have been secured to discuss various topics, among these being W. S. Murray, of the New York, New Haven & Hartford Railroad; F. W. Glading, of Pittsburg; F. N. Hibbits, of the Lehigh Valley Railroad, and C. F. Scott, of the Westinghouse Electric and Manufacturing Company.

ELECTRICAL SECURITIES.

Last week's market was decidedly irregular, with continued declines, resulting in many net losses. It is not generally believed that there will be any material change for the better for some time to come. Buying has been in the main professional. The easing money market is an important factor, and is expected to continue so for some months. Call rates were lower than during the previous week and there was a further easing of quotations for time funds and commercial paper. Industrial conditions continue favorable, with decided activity in the iron and steel trade.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JANUARY 26.

New York:	*Closing.*
Allis-Chalmers common	14¾
Allis-Chalmers preferred	38⅞
Brooklyn Rapid Transit	75½
Consolidated Gas	135
General Electric	158¼
Interborough-Metropolitan common	37
Interborough-Metropolitan preferred	73
Kings County Electric	140
Mackay Companies (Postal Telegraph and Cables) common	71
Mackay Companies (Postal Telegraph and Cables) preferred	69¾
Manhattan Elevated	141½
Metropolitan Street Railway	105
New York & New Jersey Telephone	111
Western Union	83
Westinghouse Manufacturing Company	150

J. G. Jenkins, D. H. Valentine, H. C. Duval and Eugene Foss, whose terms had expired, have been reelected directors of the Brooklyn Rapid Transit Company.

At the annual meeting of the stockholders of the Consolidated Gas Company, Walter T. Bliss and Louis I. Greer were elected trustees for the ensuing year to succeed Thomas F. Ryan and Frank N. Tilford. The other trustees were reelected. Both of the new trustees represent large stock interests.

The New York Stock Exchange has listed the New York & New Jersey Telephone Company's $18,930,500 capital stock. The company made public a report covering the ten months ended October 31 last. The report, in brief, was as follows: Gross earnings, $6,131,484; operating expenses, $4,333,683; net earnings, $1,697,801; fixed charges and taxes, $184,212; balance applicable to dividends, $1,513,589; dividends, $799,535; surplus, $714,054; previous surplus, $3,997,829; total surplus, $4,711,883.

Boston:	*Closing.*
American Telephone and Telegraph	127½
Edison Electric Illuminating	225
Massachusetts Electric	69
New England Telephone	120
Western Telephone and Telegraph preferred	77

Philadelphia:	*Closing.*
Electric Company of America	10½
Electric Storage Battery common	65
Electric Storage Battery preferred	65
Philadelphia Electric	7⅛
Philadelphia Rapid Transit	21¼
United Gas Improvement	92⅛

Chicago:	*Closing.*
Chicago Telephone	117
Chicago Edison Light	148
Metropolitan Elevated preferred	71
National Carbon common	84¼
National Carbon preferred	117
Union Traction common	—
Union Traction preferred	—

Directors of the Metropolitan Elevated Company have declared a quarterly dividend of three-quarters of 1 per cent on the preferred stock, payable March 30. Books close March 21 and reopen April 5. This is the first dividend since February, 1903. The annual meeting will be held April 4.

ELECTRIC RAILWAYS.

OWOSSO, MICH.—The Saginaw, Owosso & Lansing Electric Railway has secured an entrance into Owosso, completing its entire right of way.

HOUSTON, TEX.—Active work toward the construction of the Houston-Galveston interurban will be started in May and the work will be pushed to completion.

ANNAPOLIS, MD.—The Annapolis city council has passed an ordinance for the granting of franchises to railway companies for the operation of electric railways on the streets of Annapolis.

CHICAGO, ILL.—The line of electric railway from Elgin to Belvidere, Ill., has been completed and a trial trip made. This line is the connecting link in the road between Janesville, Wis., and Chicago and Freeport, Ill.

ALBANY, N. Y.—The state board of railroad construction has issued a certificate of necessity to the Putnam & Westchester Traction Company to build an electric road from Peekskill to Oregon, Putnam county, three and three-quarters miles.

BALTIMORE, MD.—The United Railways and Electric Company has placed in operation a 7,500-horse-power steam turbo-generator, which will supply that amount of power for the operation of street cars in Baltimore, in addition to the large power plant at present in use.

BANGOR, PA.—The following have been elected directors of the Bangor & Portland Traction Company: William Bray, R. J. Gruver, J. I. Johnson, John I. Miller, George Mutton, Joshua Bray and B. F. Dilliard. The latter was reelected president, George Raesly, secretary, and John I. Miller, treasurer.

DENVER, COLO.—The Colorado & Southern Railway has let a contract for the grading of sixteen miles of its electric line, which will be built from Denver to Boulder. The contract is for grading between Argo and Louisville Junction, which work will cost $450,000, or nearly $30,000 a mile.

HOLLIDAYSBURG, PA.—The American Street Railways Company, of Philadelphia, has filed a certificate in court of its intention to connect Hollidaysburg and Frankstown with an interurban trolley line. To reach the latter town the proposed line will traverse Bald Hill, one of the steepest in central Pennsylvania.

MENOMONIE, WIS.—The mayor has signed the street railway franchise. The Chippewa Valley Electric Company, which proposes to build an electric railway from Eau Claire to Menomonie and to operate a street railway in Menomonie, has accepted the franchise and expects to have the new line ready for business within a few months.

MINEOLA, L. I.—The Huntington Railroad Company, which is to build an electric road from Huntington to Babylon, through a part of Nassau county, has filed in the clerk's office its acceptance of the franchise granted by the Nassau supervisors, and also a check for $1,000 as a guarantee of good faith and an indemnity bond for $2,000.

THERMOPOLIS, WYO.—A franchise has been granted to the Thermopolis-Hot Springs Street Railway Company. The road is to operate between Thermopolis and Hot Springs, Wyo., and is capitalized at $50,000. The incorporators are Howard Junkins, Geo. B. Pardee, C. C. Weddle, Paul Berg and A. C. Frisby, all local business men.

ALBANY, N. Y.—The Staten Island Midland Railway Company, a reorganization of the Staten Island Midland Railroad Company, has been incorporated with the secretary of state, with a capital of $1,000,000. The principal office is in New Brighton, Staten Island. The directors include Isaac A. Levy, Mark J. Katz and Joseph G. Switzer, of New York.

SPRINGFIELD, ILL.—The Decatur, Litchfield & Taylorville Traction Company has been licensed to incorporate. The purpose is to construct an interurban railway (electric) from Decatur to Litchfield. The incorporators and first board of directors are: Dudley Taylor, Frederick W. Job, Thomas B. McConnell, Alma L. Dorothy, W. W. Taylor.

YOUNGSTOWN, OHIO—At the annual meeting of the Mahoning & Shenango Railway and Light Company, at New Castle, officers were elected as follows: president, E. N. Sanderson, New York; first vice-president, Randall Montgomery, Youngstown; second vice-president, M. E. McCaskey, New Castle; secretary, Leighton Calkins, New York; treasurer, S. C. Rogers, Youngstown.

NEW CASTLE, PA.—Application for a charter for the Beaver Falls, New Castle & Youngstown street-car line indicates a merger of all the proposed interurban lines between New Castle and the two other cities named. The right of way designated is from Beaver Falls to Hoytdale and Wampum to New Castle. A branch line is also provided for from Wampum to Ellwood. The incorporators are C. J. D. Stroheckler, N. B. Duncan, Jordan Johnson, M. Bliss Dewey and George Nye.

SPRINGFIELD, ILL.—At the meeting of the Illinois Traction Company it was given out that the proposed interurban line between Springfield and Jacksonville would be built, and that work would commence at once. It was also officially stated that a line would be built from Lincoln to Peoria in the near future. The line from Springfield to Jacksonville will be thirty-three miles long and through a densely populated country. The intention was also made known to construct a line from Danville, Ill., to Crawfordsville, Ind., thus connecting the Illinois system with the electric lines of Indiana and the East.

SPOKANE, WASH.—An order has been placed by the Spokane Traction Company for five more cars to be used on the city lines. The cars are to be made in St. Louis and patterned after the style now in use on some of the lines in the city. The dimension of the cars will be forty-one feet in length and they will accommodate 125 people. Each car will be equipped with four motors of forty horse-power each. This makes a total of fifteen cars that have been ordered by the traction company for March delivery, ten others having been ordered a few weeks ago. With the placing of these cars in commission, the Spokane Traction Company will have a total of fifty-five cars in service.

LORAIN, OHIO—At the annual meeting of the Cleveland & Southwestern Traction Company, held at Berea, President F. T. Pomeroy, in his annual report to the stockholders, submitted figures showing that the gross receipts of the company for the calendar year were $645,849, an increase over 1905 of $102,623. Net earnings after deducting operating expenses were $363,856, a gain of $53,020. During the year the company purchased fifteen new cars which, including the fifteen purchased the year before, made a total new investment in rolling stock of $225,000. The stockholders reelected former directors, and voted approval of the acts of directors in important steps recently taken for the enlargement of the system.

ALLENTOWN, PA.—At the annual election of the Lehigh Valley Transit Company, which controls the trolley lines in the Lehigh Valley, these directors were elected: E. B. Smith, W. F. Harrity, G. H. Frazier and A. E. Newbold, Philadelphia; H. C. Trexler, E. M. Young and G. O. Albright, Allentown; Tom L. Johnson, mayor of Cleveland, and David Young, of Newark. The directors reelected the old officers. The annual statement for the year ending November 30, 1906, was issued. The gross earnings amounted to $892,845, and the net profits $348,750. The total net income, after deducting taxes and interest on bonds, was $255,370. Of this surplus $93,380 was applicable to the shares of the railway company.

SAN FRANCISCO, CAL.—Ernst Thalmann, president of the United Railways Investment Company, has issued a statement that in spite of the delays and losses occasioned by the fire and strike in San Francisco, the gross receipts of the united railroads of that city for the year 1906 have decreased only $1,116,000 from the earnings in 1905, which were $5,941,000. The officers and directors of the company are confident that the earnings for 1907 will exceed those of 1905. They report that the labor situation is steadily improving and that the company now has no difficulty in obtaining all the labor necessary for the reconstruction of its old cable lines. Several of these have been completed and the entire work of reconstruction will be finished by spring.

COLORADO SPRINGS, COL.—St. Louis capitalists, represented by E. R. Stark, of Colorado Springs, expect to construct an electric railway from Colorado Springs to Denver, and will shortly ask the city council for a franchise through the streets of the city and for a terminal station. The promoters promise a rate of $1 between the

two cities and to reduce the running time from two hours and a half to one hour and forty minutes. Should the proposition be carried out, the capitalists intend eventually to continue the road to Pueblo, Cripple Creek, and possibly Cañon City and Florence. Denver will be connected with Fort Collins, Greeley and Boulder, and the entire chain of towns in the northern agricultural district. Upwards of $2,000,000 will be expended.

TRENTON, N. J.—The stockholders of the Trenton Street Railway Company, Trenton, Pennington & Hopewell Street Railway, Mercer County Traction Company and Trenton Traction Company have reelected directors as follows: Trenton Traction Company, Ferdinand W. Roebling, John A. Rigg, John L. Kuser, Remi Remont, William S. Bell. Mercer County Traction Company, John A. Rigg, Ferdinand W. Roebling, Joseph L. Caven, Peter E. Hurley, W. S. Bell. Trenton Street Railway Company, John A. Rigg, William S. Bell, Robert N. Carson, Philadelphia; Joseph L. Caven, Germantown; Ferdinand W. Roebling, J. H. Blackwell and Peter E. Hurley, Trenton. Trenton, Pennington & Hopewell Street Railway, John A. Rigg, Ferdinand W. Roebling, Peter E. Hurley, Remi Remont, Robert N. Carson, W. S. Bell, Joseph L. Caven.

SPOKANE, WASH.—Work on the Inland Empire system will be pushed forward the coming spring, a contract for 7,000 tons of sixty-pound and seventy-pound rails having been placed by the company. This steel is for the extension from Palouse to Moscow, on which grading was recently begun. A portion of it will be used for the Liberty lake line, which will be completed early in the summer. There will be sufficient left for building to Lake Pend d'Oreille and also the proposed line down the Spokane river, provided the subway franchise is granted. The extension of the Spokane & Inland from Palouse to Moscow is about sixteen miles; the spur to Liberty lake is about two miles, and the line as surveyed from Hayden lake to Pend d'Oreille is seventeen miles in length. Material for the completion of the Spokane & Inland to Colfax and Palouse is being delivered on a former contract as construction work progresses. With the completion of the Spokane & Inland to Moscow and the Coeur d'Alene extension to Liberty lake the Inland Empire system will have a total of 200 miles, not including the Pend d'Oreille and Nine Mile bridge lines.

UTICA, N. Y.—The Utica & Southern Railway Company, which has been organized for the purpose of operating a standard gauge electric road in Oneida and Madison counties; the Oriskany Hydro-Electric Company of Utica, incorporated for the purpose of equipping the line, and supplying power, and the Utica Southern Construction Company, incorporated for the purpose of constructing the line, have perfected their organization. The Utica & Southern Railway Company was organized with these officers: president, Henry J. Coggeshall; first vice-president, Adon N. Smith; second vice-president William M. West; third vice-president, Thomas F. McBride; treasurer, Fred G. Mott; secretary, Edwin H. Risley. The principal offices of the company will be located in Utica, and the company begins business, it is announced, with a capital stock of $600,000. The directors are: G. W. Sanborn, E. H. Risley, F. K. Baxter, S. A. Miller, Utica; William West, A. N. Smith, F. G. Mott, Hamilton; M. W. Terry, H. J. Coggeshall, R. W. Roberts, Waterville; H. W. Roberts, O. J. Burns, T. McBride, Clinton; H. H. Hathaway, Oriskany Falls; L. Fuess, Madison. The Oriskany Hydro-Electric Company, of Utica, the power concern, was organized with these officers: president, Henry W. Roberts; first vice-president, Thomas F. McBride; second vice-president, George W. Sanborn; third vice-president, Harry H. Hathaway; treasurer, Fred G. Mott, and E. H. Risley, secretary. The directors are: G. W. Sanborn, E. H. Risley, Utica; M. W. Terry, Waterville. The concern starts with a capital of $500,000. The intention is to establish a power plant on Oriskany creek, capable of developing 3,000 horse-power. Besides providing energy for the railway, the company proposed to provide light and power for villages. The Utica Southern Construction Company was organized with E. H. Risley as president and secretary; H. J. Coggeshall, vice-president; Fred G. Mott, treasurer. The directors present were F. G. Mott, E. H. Risley and H. J. Coggeshall. This concern is to build the road, and is capitalized at $200,000. It is the understanding that application will at once be made to the state railroad commission for consent to construct the road.

NEW INCORPORATIONS.

WATERBURY, CT.—Quinnipiac Power Company, of Meriden. $16,000.

WERNERSVILLE, PA.—Heidelberg Electric Light, Heat and Power Company. $5,000.

SPRINGFIELD, ILL.—Decatur, Taylorville & Litchfield Traction Company. $5,000. Incorporators and first board of directors: Dudley Taylor, Frederick W. Job, Thomas B. O'Donnell, Alma L. Dorothy and W. W. Taylor.

COLUMBIA, S. C.—Greenville & Greenwood Railway Company. To build a steam or electric railroad from Greenville to Greenwood. $100,000. H. H. Prince, president; S. A. Anderson, of Marietta, Ga., vice-president; F. C. Owens, Atlanta, treasurer, and T. J. Conners, secretary.

ALBANY, N. Y.—The Aero Telegraph and Telephone Company, of New York. To build and maintain lines from Trenton, N. J., to New York city, to Montauk Point on Long Island, and generally in the boroughs of Manhattan, Brooklyn, Queens, the Bronx and Richmond. $50,000, consisting of shares of $100 each. Directors: L. H. Gunther, of Brooklyn; J. D. Baker, of Yonkers, and E. B. Howard and B. S. Mantz, of New York city.

HARRISBURG, PA.—Harrisville Telephone Company. To build a line in Butler, Venango and Mercer counties, extending from Harrisville through Butler, Mercer, Slippery Rock, Murrinsville, Anandale, North Washington, Mercer, Grove City, North Liberty, Clintonville, Berkeyville, Bullion and Mechanicsville to Franklin. $5,000. Directors: W. A. McMillan, H. A. Kelly, W. B. Campbell, E. E. Wick, J. J. Imrie, J. C. Buchanan, H. L. Johnson, Harrisville.

GUTHRIE, OKLA.—The Niles Telephone Company, of Niles; $1,000; incorporators: W. F. Stipp, J. E. Starbuck and J. B. Green, of Hinton; E. E. Longfellow and H. W. Nance, of Niles. The Blue Ridge Telephone Company, of Fargo; $1,000; incorporators: G. E. Cashman and S. A. Hall, of Gage; J. J. Johnson, Louis Zahn, W. H. Morgan, J. E. Hutchinson and Will Stephens, of Fargo. The Mound View Telephone Company, of Hydro; $2,000; incorporators: W. H. Dooley, J. F. Ralf, E. J. Eperly, G. H. Reher, E. Lemon, R. S. McKee and F. L. Newton.

HARRISBURG, PA.—Beaver Falls & New Castle Street Railway Company; to build a line from Beaver Falls to Ellwood City; $60,000; president, C. J. D. Strohecker, Zeleinople. Friendship Avenue Street Railway Company, Pittsburg; $15,000; president, Moulton J. Hosack, Pittsburg. Linden Street Railway Company, Pittsburg; $27,000; president, Moulton Hosack, Pittsburg. Potato Creek Railway Company; to build twenty-eight miles of railroad from Keating Summit to Clermont; president, Marlin E. Olmsted, Harrisburg. Wampum & New Castle Street Railway Company; to build a line from Wampum to New Castle; $42,000; president, C. J. D. Strohecker, Zeleinople.

NEW PUBLICATIONS.

THE ELECTROTECHNIC CLUB, FORT WAYNE, IND.—The Electrotechnic Club, of Fort Wayne, Ind., has issued a year book containing the constitution and by-laws, together with a roll of members. This enterprising organization meets monthly, and at each session a paper devoted to some important phase of electrical engineering or physics is read and discussed.

RAILROAD DEPARTMENT, YOUNG MEN'S CHRISTIAN ASSOCIATION—The International Committee of Young Men's Christian Associations has published a handsome booklet devoted to a summary of the growth for the year 1906 and the outlook for 1907 of the railroad department. The text is supplemented by numerous illustrations of headquarters of the different railroad departments in various parts of the country.

THE KANSAS GAS, WATER AND ELECTRIC ASSOCIATION—The proceedings of the ninth annual meeting of the Kansas Gas, Water and Electric Association, held at Lawrence, Kan., October 16 and 17, 1906, have been published by the secretary. The society has a total membership of 155. The officers for 1907 are: president, E. S. Springer, Leavenworth; first vice-president, C. L. Brown, Abilene; second vice-president, F. L. Williamson, Clay Center; third vice-president, H. F. Jackman, Minneapolis; secretary and treasurer, James D. Nicholson, Newton. The next meeting of the association will be held at Topeka, October 16.

ELECTRIC LIGHTING.

PAW PAW, W. VA.—The town has voted in favor of the installation of an electric light plant.

WAYNESBORO, GA.—The private electric plant owned by J. I. Lindter has been sold to the city.

NILES, OHIO—The annual report of the municipal electric light plant for 1906 shows net earnings of $8,977.24.

DAYTON, FLA.—The city has entered into a five-year contract for street lighting with the Schantz Electric Light Company at $90 per year for each arc light.

WORCESTER, MASS.—The Worcester Electric Light Company has reduced the price for lighting the municipal buildings from eight to six cents a kilowatt-hour.

FORT PLAIN, N. Y.—A franchise has been granted to the Hudson River Power Company to string poles and wires in this village for the transmission of electricity for light and power.

HARRISBURG, PA.—Judge Kunkel, of the Dauphin county court, has issued a decree that ends the equity suit of the state against McCall Ferry Power Company. Work on the dam will now be resumed.

UTICA, N. Y.—The Hudson River Water Power Company has purchased a large tract of land in Hadley, Saratoga County, for $160,000. The land is taken for the development of the territory along the Sacandaga river.

ST. LOUIS, MO.—The electric plant of the Laclede Gas Light Company burned on January 16, with a loss of $300,000. Three thousand subscribers were affected, being without lights and power until a temporary service was established.

SOUTHBRIDGE, MASS.—Southbridge is to take its electric current for street lighting from Webster, on a moonlight schedule, with light till one o'clock, at a rate that saves $500 a year as compared with the charges of the local company.

LEBANON, PA.—The Edison Electric Illuminating Company has elected the following officers: president, John A. Rigg; vice-president, Remi Remont; secretary and treasurer, K. A. Fichthorn; solicitor, Simon P. Light; superintendent, Harry G. Louser.

COXSACKIE, N. Y.—At a meeting of the village board the contract with the Upper Hudson Electric Light Company for lighting the streets of the village was renewed for five years at $3,100 per year. Seven additional lamps are to be added and an all-night service will be given.

WASHINGTON, D. C.—Electrical Engineer Walter C. Allen has recommended to the commissioners that the regulations governing electrical wiring in the District be so amended as to provide that all service wires to buildings be placed under ground, whether connected to mains in conduits or on poles.

GALVESTON, TEX.—Improvements that will aggregate $20,000 are being made at the central station of the Galveston Electric Company. While the greater portion of this money is being expended in equipping the station with additional boiler capacity and other machinery, many alterations are being made to the building itself.

MONTGOMERY, ALA.—The Montgomery Light and Water Power Company held a directors' meeting recently at which matters were discussed by the board, outlining the policy of the company for the coming year, also for the extension of gas mains and electric lines into new territories, and for the further development of the property.

LITTLE FALLS, N. Y.—The Hudson River Power Company has filed with the city clerk its acceptance of the franchise granted to it on November 20 by the common council. With the acceptance was a bond of $10,000 furnished by the American Surety Company, guaranteeing that the company would abide by the provisions of the franchise.

ARTESIA, N. M.—The town board of trustees has granted to the Artesia Ice and Light Company a franchise to install an ice and light plant, construction on the light system to be begun within sixty days. The company is composed of business men of Artesia and Oklahoma, with a capital stock of $35,000.

ROCKFORD, MICH.—At the annual meeting of the Rouge River Electric Light and Power Company directors were reelected as follows: G. A., Samuel and Otto A. Krause, H. C. Hessler and E. W. Johnson, who in turn reelected the following officers: G. A. Krause, president; H. C. Hessler, vice-president; Samuel Krause, secretary, and E. W. Johnson, treasurer.

TAMA, IOWA—Tama is soon to vote on the bonding of the city to provide a municipal electric light plant. Ex-Mayor N. S. Beale makes the city an offer. He agrees to operate the pumping plant and electric light plant for ten years, pay the city $1,000 per year interest on bonds, and furnish water at the present rate and lights at twenty-five per cent less than paid at present.

ALLENTOWN, PA.—The Allentown Electric Light and Power Company, the last of the subsidiary companies of the Lehigh Valley Transit group, organized by the election of these officers: president, Col. H. C. Trexler; vice-president, E. M. Young; secretary, Charles N. Wagner; treasurer, C. N. Wagner; directors, David Young, John C. Dawson, Edward Thomas and T. E. Ritter, beside the above-named officers.

MOBILE, ALA.—Mayor Lyons and President Jackson, for the Mobile Electric Company, have signed the contract for the lighting of the city offered by the electric company, and amended in two particulars by the city council, thus settling for ten years the lighting of the city streets and the rates to domestic consumers. The city gets nearly 200 more lamps for street lighting at the same annual outlay as for the lights now in service.

PARK RIDGE, N. J.—The municipal ownership electric light at Park Ridge has been advertised to be sold at public auction at the court house, in Hackensack, on the afternoon of February 19. The plaintiffs against the Park Ridge borough council are C. E. Hewitt & Company, who built the plant. United States Marshal Alcott levied on the plant to satisfy a judgment of $6,000 secured in the United States District Court, at Trenton, before Judge Lanning.

KALAMAZOO, MICH.—Improvements which mean the expending of over $100,000 by the Commonwealth Power Company in Kalamazoo will be started at once by the company. The rewiring of certain districts of the city and the extending of the services to sections not at present reached is part of the plan. Jackson and Kalamazoo are now connected by power lines and it is the intention of the company, in the near future, to develop more power for the service.

ALBANY, N. Y.—An application has been filed with the state lighting commission by the West Shore Electric Company, asking consent to furnish the towns of Coeymans and New Baltimore with lights. The Upper Hudson Electric Company furnishes lights in the village of Ravena, located in the town of Coeymans. The petitioner asks also for authority to issue $30,000 of its authorized capital stock and also to issue bonds in the amount of $25,000, the proceeds of both issues to be used in purchasing property and in construction and equipment work.

OKLAHOMA, OKLA.—The Muskogee electric light, gas and ice plant has been sold to a syndicate of Oklahoma, Chicago and New York capitalists, a charter having been issued at Guthrie incorporating the new company. A natural gas plant is also included in the deal and the capitalization is $1,500,000, indicating that the metropolis of the Creek nation is to have its public utilities developed upon a very large scale. D. T. Flynn, of Oklahoma, is president of the new company, and C. Hiser, also of Oklahoma, is secretary. The other Oklahoma City stockholders are C. B. Ames, O. L. Avey and H. B. Carson.

WESTERVILLE, OHIO—The board of public affairs has entered into a contract with the Westerville Electric Company whereby the present plan of lighting the streets, stores and homes will be continued until the new municipal light plant is erected. Bond was given the board for the faithful carrying out of this contract, after which the board turned over to the electric company $2,500, the purchase price for the outside construction, franchise and privileges for the use of telephone poles. This was in accordance with the agreement, made before the bond issue for the municipal light plant was submitted to the people.

TELEPHONE AND TELEGRAPH.

NEW YORK, N. Y.—The Atlantic Telephone Company, independent, whose application for a franchise in this city has been on file for some months, will install a specimen plant in police headquarters.

IRON MOUNTAIN, MICH.—The Amberg Telephone Company will build a toll line from Pembine to Niagara. The company already has toll lines to Wausaukee and Pembine. Lines will also be built to towns on the Wisconsin & Michigan road as far east as Miscouno Inn.

MONTROSE, PA.—The Montrose Telephone and Telegraph Company at its annual meeting elected the following directors: C. A. Jayne, W. D. B. Ainey, E. B. Lacey, H. J. Brande and R. B. Swisher. The officers elected are: president, C. A. Jayne; secretary and treasurer, H. J. Brande.

SPARTA, TENN.—The Gainesboro Telephone Company, with headquarters at this place, has made the Union Bank and Trust Company trustee in a mortgage for $100,000 on its holdings in Tennessee and Kentucky to secure first mortgage bonds which are now being placed on the market. The territory covered is in Tennessee and Kentucky, embracing twenty-five exchanges and twenty-five hundred miles of toll line.

SALT LAKE CITY, UTAH—The Blue Mountain Telephone and Electrical Company, of Moab, formed to do a general telephone and telegraph business in Utah and Colorado, has filed articles of incorporation with the secretary of state. It is capitalized for $10,000, the par value of the shares being $1. The officers are: president, D. Goudeleck; vice-president, J. M. Cunningham; treasurer, V. P. Martin; secretary and manager, J. N. Corbin.

CLEVELAND, TEX.—At a stockholders' meeting of the Cleveland Telephone Company it was decided to increase the capital stock from $1,000 to $2,000 and build a line from Cleveland to Thicket, in Hardin county. The directors elected officers for the ensuing year as follows: president and general manager, J. T. Tanner; secretary, M. W. Harrell; treasurer, Dr. T. A. Boothe. The Cleveland Telephone Company now has connection with the Southwestern Telegraph and Telephone Company.

WASHINGTON, D. C.—The annual report of the Chesapeake & Potomac Telephone Company on its operations in the District of Columbia during the calendar year 1906, has been submitted to Congress, showing receipts aggregating $1,011,119.73 and expenditures aggregating $860,231.67, leaving net earnings amounting to $150,888.06. The sum of $101,648.30 is set down for depreciation, leaving the revenue balance at $49,239.76. The cost of work, not including real estate in the District of Columbia, up to December 31 last, is given as $3,325,358.63. During the year $281,514.51 was spent on construction of underground conduits and cables, $279,170.20 on central office equipment and $84,331.98 on poles and aerial wires. Telephone earnings during the year were $956,574.73 and the real estate earnings $54,545.

ALLENTOWN, PA.—At the annual meeting of the Consolidated Telephone Companies of Pennsylvania, the following directors were elected: George O. Albright, R. E. Wright, Allentown; A. J. Brumbach, Reading; Thomas Daugherty, Allentown; Frank M. Green, Washington, D. C.; Wilson J. Hartzell, Allentown; J. P. Helfenstein, Shamokin; A. P. Trautwein, Carbondale; George N. Reichard, Wilkes-Barre; John R. Hendel, Reading; Geo. R. Bedford, Wilkes-Barre; W. A. Lathrop, Philadelphia, president of the Lehigh Coal and Navigation Company; C. D. Simpson, Scranton; I. A. Stearns, Wilkes-Barre; C. W. Kline, Hazleton. Mr. Hendel takes the place on the board of Isaac Hiester, of Reading. The board elected these officers: president, Robert E. Wright; vice-president, C. W. Kline; secretary and treasurer, C. M. W. Keck, Allentown; general superintendent and assistant secretary, Charles West, Allentown. The annual report of Superintendent West shows gross revenues of $376,659.94. After deductions for operation and maintenance applicable to fixed charges, there was a balance of $176,530.59, and a very satisfactory surplus. There are thirty-eight exchanges and 16,944 telephones. The increase in telephones was 22.6 per cent during the year, and the gross revenue from toll business was nearly $70,000. More than $3,000,000 worth of stock was represented at the meeting.

INDUSTRIAL ITEMS.

THE INTERNATIONAL ELECTRIC METER COMPANY, Chicago, Ill., is distributing an attractive calendar for 1907.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., has issued a revised edition of its bulletin No. 1,045, descriptive of Allis-Chalmers rotary converters.

M. W. DUNTON & COMPANY, 65 Atlantic avenue, Providence, R. I., is issuing an attractive calendar for 1907. This calendar shows the products which the company manufactures.

V. C. GILPIN, 120 Liberty street, New York city, announces that he has been appointed eastern sales agent for the Sterling Electric Company for its flexible steel conduit and armored conductor.

THE EUREKA PACKING COMPANY, 48 Warren street, New York city, is distributing an attractive folder entitled, "A Short Argument." This details the advantages secured by the use of "Eureka" packings for engines and pumps.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., announces the cancellation of bulletin and price list No. 79½, dated May, 1906, covering drum-type machine-tool controllers with automatic release. The superseding bulletin will be mailed at an early date.

THE PIERCE SPECIALTY COMPANY, Elkhart, Ind., has published a new catalogue descriptive of steel construction specialties for telephone, telegraph, electric light, power, transmission and all other electrical purposes. In addition to the text there are numerous illustrations, both of individual pieces of apparatus and typical applications.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., has published a series of booklets devoted to motor applications. These include motor-driven blacksmith blowers, dish washers, sweeping and scrubbing apparatus, ticketing machines, ice-cream freezers, sewing machines, coffee grinders and dough-mixing machines. Any of these bulletins will be furnished upon request.

THE ECK DYNAMO AND MOTOR WORKS, Belleville, N. J., has been reorganized and a new company formed to take over the business formerly operated by C. A. Eck. The officers of the new company are: president and treasurer, William J. Wallace; vice-president, Walter G. Clark; secretary, Charles H. Dilg. The old name of the company will be continued, and the Eck dynamos and motors and fan-motor apparatus will be manufactured as heretofore.

THE WESCO SUPPLY COMPANY, St. Louis, Mo., and Fort Worth, Tex., announces a new factory building at the corner of Eighth street and Clark avenue, St. Louis. This five-story brick building has been equipped with the most modern machinery for the manufacture of a complete line of telephone instruments and accessories. The factory is now in operation. A portion of it is being equipped for the manufacture of knife switches, panel boards, cut-out cabinets and switchboards. Other electrical specialties will be brought out from time to time.

THE BENJAMIN ELECTRIC MANUFACTURING COMPANY, Chicago, Ill., has published two catalogues devoted to wireless clusters and lighting specialties. Catalogue B-17 forms a ready reference book on these devices. The general construction is described, together with suggestions for the use of Benjamin wireless clusters. Instructions for ordering are also given, and detailed descriptions, together with capacities and prices. Catalogue B-17A is smaller in size, and is intended for a reference catalogue where the larger work is not available. Both of these catalogues will be sent to any one interested upon request.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has issued a new series of advertising literature. Bulletin No. 4,469 describes pocket instruments, types O and OS, for direct or alternating current, and supersedes bulletin No. 4,378. Bulletin No. 4,472 describes and illustrates mercury arc rectifiers, superseding bulletin No. 4,411. The GE-76 railway motor is described in bulletin No. 4,474; type PP dial controllers in bulletin No. 4,476; accessible manhole junction boxes, type SD, in bulletin No. 4,477 (superseding No. 4,326); parts of type K series parallel controllers in bulletin No. 4,478 (superseding catalogue No. 7,560); pipe thawing

transformers in No. 4,480; and the General Electric automatic time switch, type T, for alternating and direct-current circuits, in bulletin No. 4,483. In bulletin No. 4,479 is given a description of the Toledo & Chicago interurban single-phase railway, by John R. Hewett. There is also an errata to accompany bulletin No. 4,441, descriptive of type H subway transformers, and revised pages 57, 58, 59 and 60, for the G. E. specialties catalogue, dated June, 1906.

THE GERMANIA ELECTRIC LAMP COMPANY is now well established in its new factory, which is located at 420-422 Ogden street, Newark, N. J. After a business career of seven years in Harrison, N. J., the company out-grew its plant there and has been obliged to move into larger quarters to supply the greatly increased demand for lamps of the "Germania" standard and reflector types. The new factory is a modern, well-lighted building, centrally located and well adapted for the manufacture of electric lamps. The company has materially enlarged its equipment of up-to-date lamp-making machinery, which increase, together with a large and carefully assorted stock, enables it to make prompt shipments. The "Germania" lamps are made in practically all standard types, and they also include a special reflector lamp which is meeting with marked success. This is due to its having a backing of metallic copper instead of the usual enamel paint, and as the copper is not affected by heat, it is claimed that the reflector gives efficient service during the whole life of the lamp. The Germania Electric Lamp Company wishes it announced that its factory is operated independent of any understanding or agreement with any other manufacturer or association of manufacturers of electric lamps.

Record of Electrical Patents.

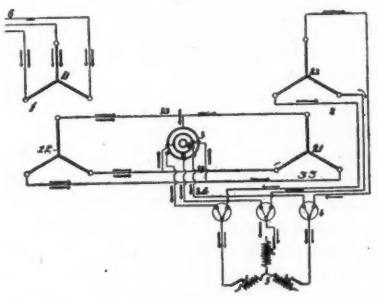
Week of January 22.

841,709. ELECTRIC BRAKE. Frank C. Newell, Wilkinsburg, Pa., assignor to the Westinghouse Air Brake Company, Pittsburg, Pa. Braking and running controllers are provided, both of which actuate the brake.

841,710. ELECTRIC BRAKE. Frank C. Newell, Wilkinsburg, and Edward H. Dewson, Edgewood Park, Pa., assignors to the Westinghouse Air Brake Company, Pittsburg, Pa. The momentum of the car drives a dynamo controlled by shunting the field.

841,720. ELECTROLYTIC APPARATUS. John H. Ryan, Portland, Ore. Plates placed in the bath deflect the electrolyte.

841,747. TELEPHONE TRUNKING CIRCUITS. Harry G. Webster, Chicago, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill. A number of relays at the incoming end of the trunk enable the current to be cut off from it.

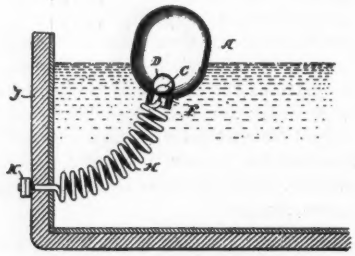


841,874.—ROTARY CURRENT MOTORS CONNECTED IN CASCADE SYSTEM.

841,765. ILLUMINATING APPARATUS. Norman D. Bishop, Los Angeles, Cal., assignor to Donald G. Bishop, Los Angeles, Cal. A glass tube containing movable illuminating devices.

841,769. TELEPHONE TRUNKING SYSTEM. William W. Dean, Chicago, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill. A testing outfit is combined with a relay to control the connection of the circuit.

841,820. ELECTRIC ARC LAMP. Braxton L. Scott, Washington, D. C. The lamp is regulated by a pair of series magnets.



842,082.—CIRCUIT CLOSER.

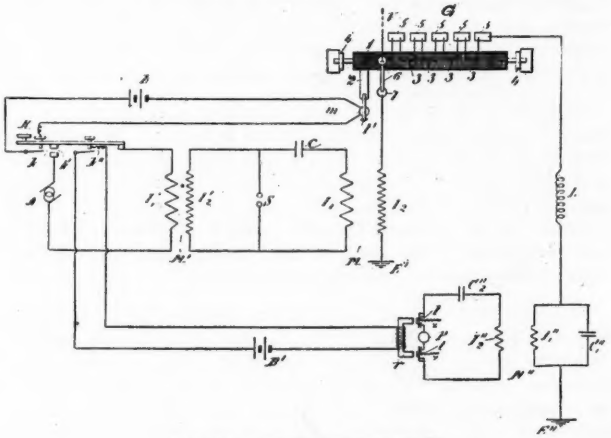
841,849. ELECTROTHERMAL PROTECTOR. Frank B. Cook, Chicago, Ill. The melting of an easily fusible insulating material closes the circuit.

841,855. ELECTRIC SIGNAL. William F. Dreer, Coulters, Pa. The wheel flanges open and close the signal circuit.

841,870. HOISTING APPARATUS. Charles H. Hunt, New York, N. Y. The motor, running as a generator, provides an additional brake.

841,874. ROTARY CURRENT MOTORS CONNECTED IN CASCADE SYSTEM. Coloman de Kandó, Budapest, Austria-Hungary, assignor to Westinghouse Machine Company. Several rotors are placed on the same driving shaft with means for connecting them electrically.

841,975. ELECTRICALLY OPERATED HAMMER. Ronald P. Irving, Quincy, Mass. The hammer is operated by a solenoid.



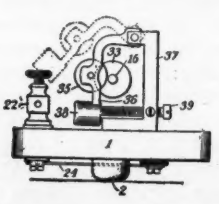
842,134.—SPACE TELEGRAPHY.

841,993. TELEPHONE SWITCH HOOK. Ray H. Manson, Elyria, Ohio, assignor to the Dean Electric Company, Elyria, Ohio. A hook stamped and folded from sheet metal.

842,020. RECEPTACLE FOR INCANDESCENT ELECTRIC LAMPS. Bert E. Salisbury, Syracuse, N. Y., assignor to Pass & Seymour, Incorporated, Solvay, N. Y. Grooves are provided in the porcelain bases for holding the wires.

842,082. CIRCUIT CLOSER. Ernest S. Clayton, Newark, N. J. The circuit is opened and closed by the change in position of the float.

842,099. ELECTRIC MELTING OR REDUCING FURNACE. Gilbert C. Landis, Carlisle, Pa., assignor to American Phosphorous Company, Camden, N. J. A furnace with a fluid gas seal.



842,154.—TELEGRAPH TRANSMITTER.

842,134. SPACE TELEGRAPHY. Sewall Cabot, Brookline, Mass., assignor to Stone Telegraph and Telephone Company, Boston, Mass. A high-potential key switch enables the antenna to be connected to the sending or receiving apparatus.

842,154. TELEGRAPH TRANSMITTER. Horace G. Martin, New York, N. Y. Two contacts are provided, one being carried on a vibrator.